FIG. 3. LOOKING OVER SITE OF BRIDGE AFTER WASHOUT

of course not much resistance to overturning from a pressure in this direction.

It appears, however, from a statement by C. M. Scott, Superintendent at Phœnix, who saw some of the spans go out, that the piers did not fail by overturning, but from scour. It is said that the water rushing under the web bracing scoured so deeply that the piers simply dropped down out of sight. There is no trace left of a single one of them. Two of the eight deck girder spans are in the river some 200 to 500 ft. below the bridge. They are apparently undamaged, and an attempt will be made to recover them. Others may be located during the placing of the foundations for the new piers. One of the two located spans may be noted in Fig. 6.

Proposed Method of Reconstruction

It is proposed to reconstruct the eight spans on concrete piers. Interlocking steel sheet piling will be driven in the river to a depth of 30 or more feet, and the interior of the caisson thus formed will be excavated. Piles will then be driven to a depth of approximately 30 ft. below the bottom, as before, and the interior of the caissons will be filled with concrete, leaving in the steel piling as forms. The bases of these piers and of the existing piers at the river bottom will be surrounded with large stone riprap to take care of scour, the idea being to use stones large enough to hold their places and drop down in case of under-scour.

Besides the loss of eight bridge spans, about 500 ft. of the embankment at the north end of the bridge was washed out by the sideswiping action of the flood waters. The remainder of the fill was saved only by the use of brush and wire mattresses. These were made of Page wire fencing laid out on the rails and woven full of brush. The mats were then laid on the face of the fill and weighted with stone and rails.

The railway traffic was interrupted for about a week, during which time pile trestles were built across the breaks. The fill has been replaced and the toe of the embankment protected with large-sized riprap. As an additional safeguard against another flood's sideswiping the embankment a short jetty, about 100 ft. long, made of large pieces of stone, is to be built at right angles to the fill at the end near the bridge abutment.

For the data and some of the illustrations in this article *Engineering News* is indebted to L. H. Long, Vice-President and Chief Engineer, C. M. Scott, Superintendent, and L. M. Hitchcock, Division Engineer, of the Arizona Eastern R.R. The reconstruction pictures were taken by a member of the staff, Mar. 18, 1916.

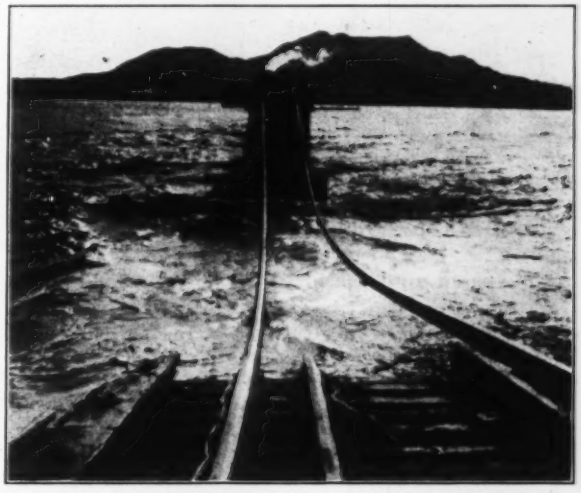

FIG. 5. JUST AFTER FIRST SPAN WASHED OUT

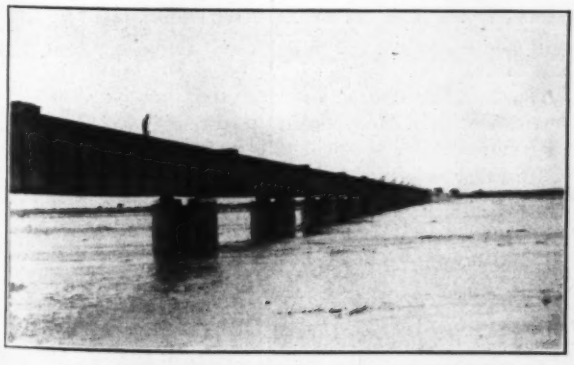

FIG. 4. LOOKING NORTH TOWARD TEMPORARY TRESTLE IN BACKGROUND

FIG. 6. ONE OF THE LAST SPANS IN ITS PRESENT RESTING PLACE

Foam-System Installation for Fighting Oil Fires

By C. P. Bowie*

SYNOPSIS—Protection of oil-storage tanks from fire by use of foam extinguishers. Formulas for solutions. Details of plant installed at Coalinga, Calif.

The foam system of fighting oil fires consists essentially of bringing together two chemical solutions, which on combining produce a thick tenacious foam, and of spreading this foam over the surface of burning oil, thereby excluding the oxygen of the atmosphere and hence extinguishing the flame. The practical application of the scheme to a concrete case is described in the paragraphs that follow. This process, so far as can be determined, is of German origin; its possibilities as a fire extinguisher for highly inflammable hydrocarbon compounds are said to have been first demonstrated in the fall of 1905 at one of the government laboratories at Hamburg. In 1909 it was reported upon by United States Consul T. H. Norton, of Chemnitz.

For a great many years it has been the practice among oil companies in the United States to protect tanks and reservoirs used for the storage of crude as well as refined oils, by a system of steam piping so arranged that in case such a receptacle is struck by lightning or otherwise ignited, the space between the surface of the oil and the roof can be quickly filled with steam. If the roof remains intact long enough for the steam to fill all of this space, such an arrangement will usually put the fire out. However, in the majority of cases where a storage tank or reservoir catches fire, the gas above the surface of the oil will explode and so badly shatter the roof that efforts to smother the flames with steam are useless. So it is that the foam system, having proved its adaptability to this class of fire-fighting, is rapidly being installed at storage "farms" and refineries of many of the larger oil companies and bids fair to be generally accepted.

The apparatus required for the practical application of such a process consists of two tanks—one for each of the chemical solutions—a suitable pump, pipe lines to carry the solutions to the oil tanks or reservoirs, mixing boxes where the chemicals can be combined and a means for properly distributing the foam.

In general the solutions for producing the foam may consist of any two compounds which, on coming together, will form an abundance of relatively tough bubbles, the inflating gas of which is itself noninflammable. The chemicals used must be fairly cheap; also they must be of such a nature that they will not deposit any appreciable amount of sediment after having been in solution for a long period of time. Each of the accompanying formulas has given satisfactory results.

In all the formulas solution A and solution B are to be combined in equal parts to produce a maximum amount of foam. The usual test is to pour 50 c.c. of solution A into a graduated tube and 50 c.c. of solution B into a similar tube. The resultant foam formed by combining the two should be between 600 and 800 c.c. Solution A, because of its acid reaction and consequent corrosive effect on iron, must be stored in a wooden tank or, if a steel tank be used, it must be lined with lead or some other acid-resisting material.

Such a system was recently installed by the Associated Pipe Line Co. at its Coalinga pump station, near the town of Coalinga, Fresno County, Calif. Some details are appended.

Solution Tanks of Coalinga Installation

This installation was designed to protect four 55,000-bbl. tanks each 114 ft. 6 in. diameter, one 37,000-bbl. tank 95 ft. 6 in. in diameter, one 30,000-bbl. tank 86 ft. in diameter and two fuel-oil tanks each about 8 ft. in diameter. Estimating 6 gal. of foam for 1 gal. of solution to produce over the surface of the various tanks a blanket of foam 5 in. in thickness in 5 min. would require that each solution be delivered at the rate of 550 gal. per min. for the 55,000-bbl. tanks, 368 gal. per min. for the 37,000-bbl. tank, 308 for the 30,000-bbl. tank and about 6 for the fuel-oil tanks. That is to say, to cover each tank once with 5 in. of foam would require about 6,200 gal. of each solution. In order to provide a reasonably large surplus of solution, in case it should become necessary to cover all the tanks with foam during a single conflagration, it was determined to use solution tanks 15 ft. 7/8 in. in diameter by 11 ft. 9 in. in height, having a capacity of 15,695 gal. each. These were made from No. 10 U. S. G. galvanized iron, all seams riveted and soldered. Each tank was provided with a 6-in. suction outlet placed on the side 3 in. from the bottom.

FORMULA 1 (COMPONENTS ON A WEIGHT BASIS)

Solution A	Solution B
100 parts water	100 parts water
14 parts aluminum sulphate (crystal)	9¼ parts sodium bicarbonate
3 parts powdered extract of licorice	

FORMULA 2 (COMPONENTS ON A WEIGHT BASIS)

Solution A	Solution B
100 parts water	100 parts water
12 parts aluminum sulphate (crystal)	10 parts sodium bicarbonate
½ part acetic acid	1 part ground glue
1 part ground glue	½ part glucose
½ part glucose	

FORMULA 3 (COMPONENTS ON A WEIGHT BASIS)

Solution A	Solution B
100 parts water	100 parts water
10 parts aluminum sulphate (crystal)	1¼ parts ground glue
½ part sulphuric acid 66°B	½ part glucose
	7½ parts sodium bicarbonate
	3/5 part arsenious oxide

The tank for solution B, or the soda solution, was also provided with a 3-in. drain in the bottom. The one for solution A, or the acid solution, was lined with lead 1/8 in. thick weighing 8 lb. per sq.ft. In lieu of a drain for this tank a depression was made in the bottom (located immediately beneath the hatch) by riveting on a pan 1/2 in. deep by 12 in. in diameter. In case it should become necessary at any time to empty this tank, that portion of the liquid below the 6-in. pipe can be removed with a steam ejector or siphon, one end of which is placed in the depression. This was considered to be a cheaper and much more satisfactory method than using pipe for

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a drawoff, since the pipe would require to be made of lead or be lead-lined.

The tanks were placed on 4x12-in. redwood planking laid on mudsills on top of an earthen grade built up about 3 ft. above the pump foundation, in order that the solutions at all times might flow to the pumps under static head rather than through suction. The tops of the tanks were made of wood covered with roofing paper, the rafters being supported by the shell of the tank.

Since each solution tank is charged with that proportion of chemicals which will produce a maximum amount of foam on combination of equal parts of the solutions, it is very important that the pumps that are to deliver the solutions from their respective storage tanks to the mixing boxes at the oil tanks be designed to deliver as nearly as possible the same quantities in a stated time. Several types of pumps were considered. The duplex reciprocating type with a separate suction to each plunger (using one plunger for acid solution and the other for soda) was deemed undesirable not only because of the liability of one side of the pump short-stroking, but also because of the necessity of bringing such a pump slowly up to capacity when the time element might prove a most important factor. The first of these defects could be practically overcome by the use of a crank and flywheel pump. But the added first cost for such an installation, coupled with the loss of time in starting—which could not be overcome—seemed sufficient drawbacks to warrant the use of some other type.

The unit finally selected consisted of two 4-in. double-suction single-stage horizontal-shaft centrifugal pumps direct-connected to a 110-hp. impulse-type steam turbine.

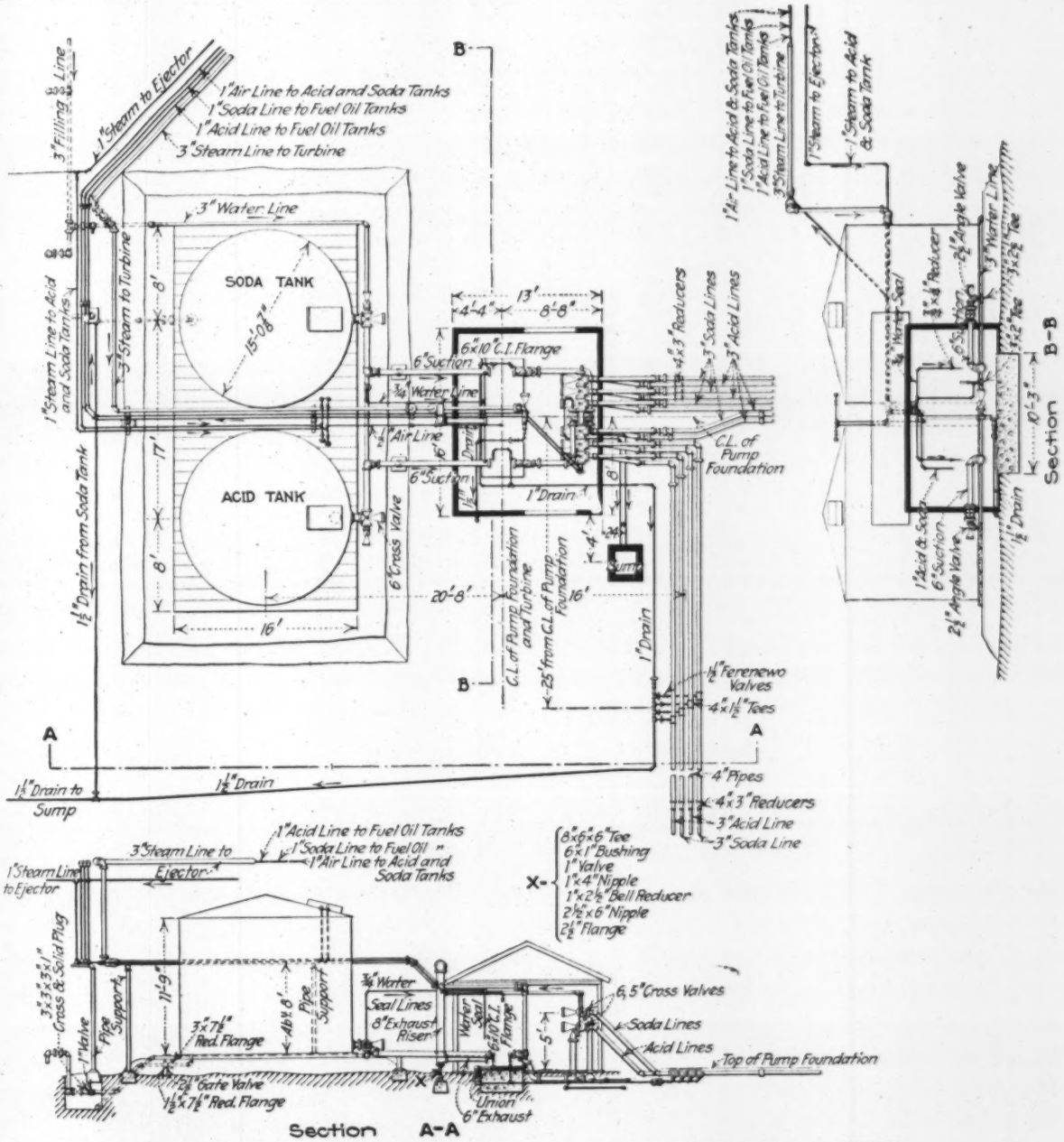


FIG. 1. GENERAL ARRANGEMENT OF FOAM SYSTEM AT COALINGA, CALIFORNIA

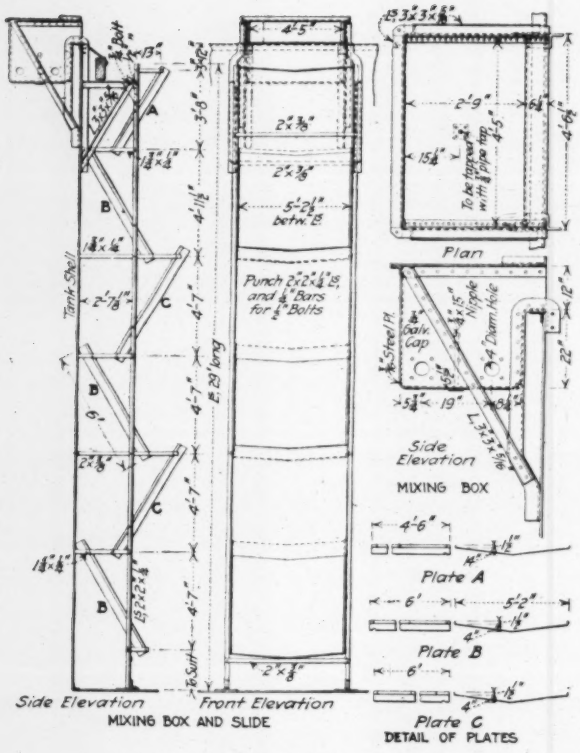


FIG. 2. FOAM-CHUTE DETAILS

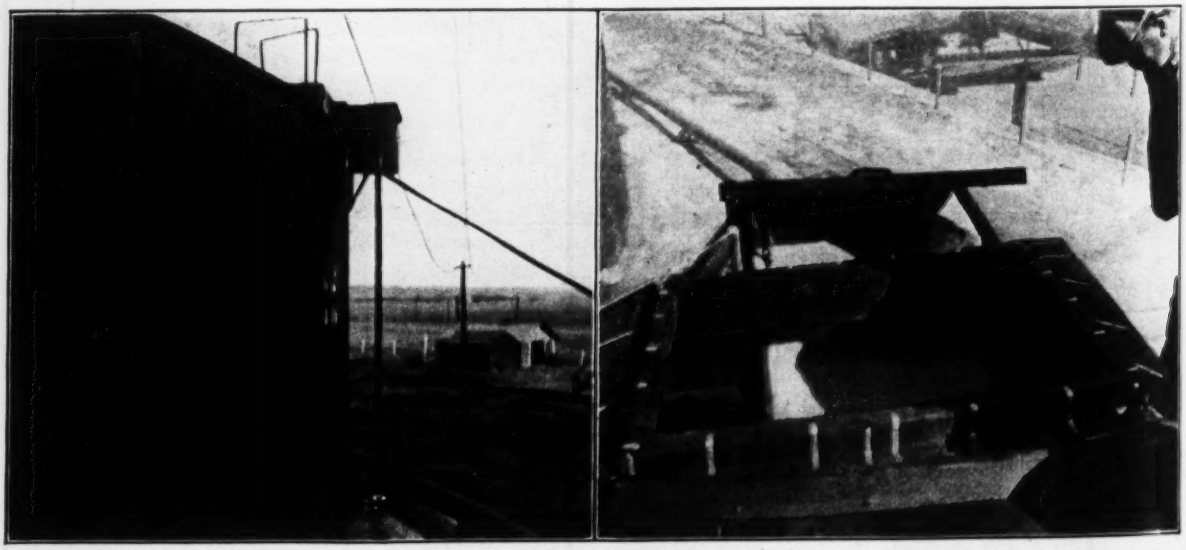
The whole was mounted on one bedplate. This unit was designed to deliver 550 gal. per min. against a head of 200 ft. with a steam pressure of 140 lb. per sq.in. The impeller and the wearing rings in the pumps used for solution "A" (the acid solution) were made from "acid bronze"; otherwise the working parts of both pumps were of cast iron.

An example of the positive action of such an installation is interesting: During a test of the system the foam was pouring into an oil tank, 470 ft. distant from the turbine house, in 1 min. 40 sec. (at the end of which time the pumps were working up to capacity) after the blowing of the whistle that announced the supposed fire.

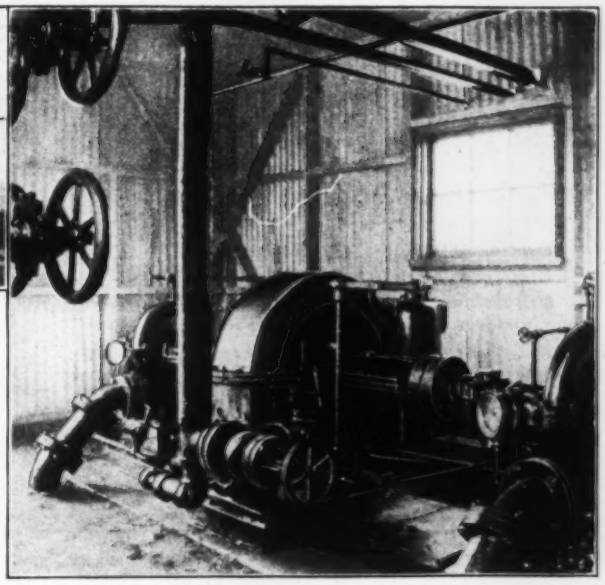
A separate system of piping, controlled from the turbine house, carries each solution to the respective tanks. This is arranged by allowing each pump to discharge into a manifold composed of 5-in. cross-valves placed end to end as shown in the illustration. The solution B manifold is immediately above solution A manifold, with the corresponding valves in each opposite each other. The stems of these valves are connected by sprocket chains so that the operator in opening an acid valve, which allows that solution to flow to a certain mixing box, is at the same time and at the same rate opening the valve admitting soda solution to the same mixing box. This then insures the proper proportion of delivery of the chemicals from the very outset of the pumping operation. Each valve is plainly marked with the number of the oil tank to which it supplies solution, and when the system is not in use all the valves are kept closed.

The pipe used was the ordinary mechantable galvanized-iron pipe from 1 to 4 in. in diameter, the size depending on the amount of liquid to be carried. The 1-in. pipe, which is taken off of the ends of the manifolds, serves the fuel-oil tanks. On account of the relatively high percentage of alkaline salts in the soil at this pumping station and their consequent corrosive effect on iron, all those portions of the lines that were buried in the ground before being laid were treated with a coat of refined asphaltum, then wrapped with asbestos roofing paper and again coated with asphaltum. All of the lines were carefully placed on true gradients, and drains were provided at the low points so that after any part of the system has been used the chemicals remaining in the lines may be drawn off and the pipes flushed with water.

The 6-in. suction nozzle from the solution A, or acid tank, was lead-lined up to the suction valve, about 8 in. from the tank. The valve itself had to be especially constructed. It was made by taking a Crane 6-in. flanged cross-valve and replacing the disk, seat, collar and valve sleeve with fittings made from an acid-resisting metal composed of about 5% antimony and 95% lead. The antimony was added not to increase the resistance to chemical action, but to make the metal more crystalline



FIGS. 3 AND 4. MIXING BOX ATTACHED TO 55,000-GAL. TANK; FOAM DISCHARGING INTO OIL TANK



FIGS. 5 AND 6. COALINGA SOLUTION TANKS AND TURBINE HOUSE; STEAM TURBINE AND CENTRIFUGAL PUMPS

and hence better adapted to withstand the wear and tear to which the working parts of such fittings are necessarily subjected. When the valve is closed, as is the case except when the system is in actual operation, all the parts that come in contact with the acid are thus composed of acid-resisting material. As a precaution against the valve leaking and allowing the acid to get into the suction piping, a ½-in. drain is provided in the bottom, which is kept open when the system is not in use. The water suction for flushing the lines is connected to one leg of this valve. The pipe lines discharge into mixing boxes. Each oil-storage tank is provided with one of these boxes supported by the shell of the tank and extending about 1 ft. above the top angle-iron, as shown in detail on the accompanying drawing. By having the box outside the tank it is believed that it and the pipes leading to it will escape serious damage from the usual gas explosion and, even though the roof of the tank collapses, will still be able to deliver foam upon the blazing surface.

Mixing Boxes and Foam Slides

The boxes were made from $\frac{3}{16}$-in. steel plate and are rectangular in shape. The ones for the 55,000-bbl. tanks are 4 ft. 5 in. by 2 ft. 9 in. by 2 ft. 10 in. deep, inside dimensions. They are provided with a lip 6¼ in. wide extending entirely across one side at a distance of 1 ft. 10 in. from the bottom. This lip rests on top of the tank shell and forms a weir over which the foam is delivered into the tank. The boxes for the 37,000- and 30,000-bbl. tanks are of similar construction but of smaller dimensions.

The solutions are brought into the bottom of the boxes through headers perforated on the under side with slotted holes. In this way they are given an opportunity to mix thoroughly before being discharged over the weir. The boxes for the fuel tanks consist merely of pans about 14 in. square and 10 in. deep, made of galvanized iron. They are supported at the centers of the tanks, beneath the roof, by the solution pipes themselves.

In case the tank that becomes ignited should contain only a few feet of oil, it is thought best that the foam, although the bubbles of which it is composed are surprisingly tough, should not be allowed to fall freely from the top of the tank to the surface of the oil, for the reason that many of the bubbles might be destroyed by the impact of the fall. To overcome such a possible defect a series of slides or baffle-plates were constructed from No. 10 U. S. G. black iron supported by 2x2x¼-in. angles, as shown on the drawing. The bubbles pouring from the mixing box fall upon the uppermost baffle-plate. Those which actually come in contact with the metal of the plate adhere to it to a marked degree and, because of their sticky nature, retard the whole mass. The result is that when the foam arrives at the bottom of the tank after having passed over a series of these baffles, its velocity is not very much greater than when leaving the mixing box.

In preparing the chemical compounds for the Coalinga plant each solution tank was filled with fresh water to within about 2½ ft. of the top (formula No. 3 was used). For solution A, or the acid solution, the water was then heated with open steam to a temperature of 180° F. and the aluminum sulphate and sulphuric acid added. During the addition of the chemicals a thorough agitation was kept up with compressed air. For the soda solution, the ground glue was first added slowly to the water before heat was applied and the mixture was thoroughly agitated. It was then raised to a temperature of 160° F. and the glucose and bicarbonate of soda put in and agitated until all three were completely dissolved. Lastly, the arsenious oxide was put in. Both tanks were then filled to the top with water, and agitation was continued until no undissolved chemical could be detected on the bottom of the tanks by stirring with a long pole. The solutions were then allowed to stand for 24 hr., after which time they were again tested with the pole and showed an apparently uniform mix in each tank. It has been suggested that a much better way to test for a homogeneous mix would be to "thieve" the tank at various depths and compare the samples so taken as to gravity, and in future this method probably will be followed.

Since the glue will slowly decompose, more must be added from time to time. Each solution will therefore be tested, as previously outlined, at least once a month, and whatever additional components are required to bring it up to specifications will be supplied.

When the system has been used for fire or test, the acid remaining in the acid pipe lines is first drawn off. Then these pipes are filled with the soda solution, which is allowed to stand several minutes, or long enough to neutralize all the acid, before being drawn off. The system is then thoroughly washed with water.

Status of Activated-Sludge Sewage Treatment

By George T. Hammond*

SYNOPSIS—After visits to five working-scale plants the author, who has been in engineering charge of activated-sludge experiments at Brooklyn, draws some noteworthy conclusions regarding the probable desirability of preliminary screening, the apparent advantages of pipe-grid as against porous-plate or porous disk diffusers, the uncertainty, but great importance, of sludge recovery for fertilizer base and of sludge dewatering. He considers the activated-sludge process, while promising, as still in the early experimental stage, but fortunately the experiments are on a large scale and in charge of able men.

Sewage treatment by aëration in the presence of activated sludge has now been under extensive observation and experiment in this country in plants provided on a working, rather than a mere laboratory, scale for about one year, the earliest having been started in March, 1915. Considerable work has been done on this method in Brooklyn, and much that has been accomplished there has already been published. A careful analysis of results led to the desire for comparison with the achievements of others in this field, and visits were planned to each of the larger plants engaged in this study.

Within the last few weeks the writer has visted Baltimore, Milwaukee, Chicago and Cleveland, and the observations and conclusions expressed in the present article are the result of these visits and of the experience gained from the Brooklyn plant. Two plants were studied at Chicago—that of Armour & Co. and that conducted by the Sanitary District of Chicago. The data presented are derived from the six plants.

The first conclusion reached is that the principle offers a method by which clarification of sewage may be secured with reliability, though at a rather questionable cost, and that further experimental work to clear up doubtful points may in many places render its employment attractive, but that the expense of obtaining a high degree of stability will be relatively high. One of the principal advantages offered is the clear and sparkling effluent that may be secured, and of much importance also is the absence of all smell from the aërating tanks.

The second conclusion is that the method is not without many difficulties, some of which, unless overcome, are

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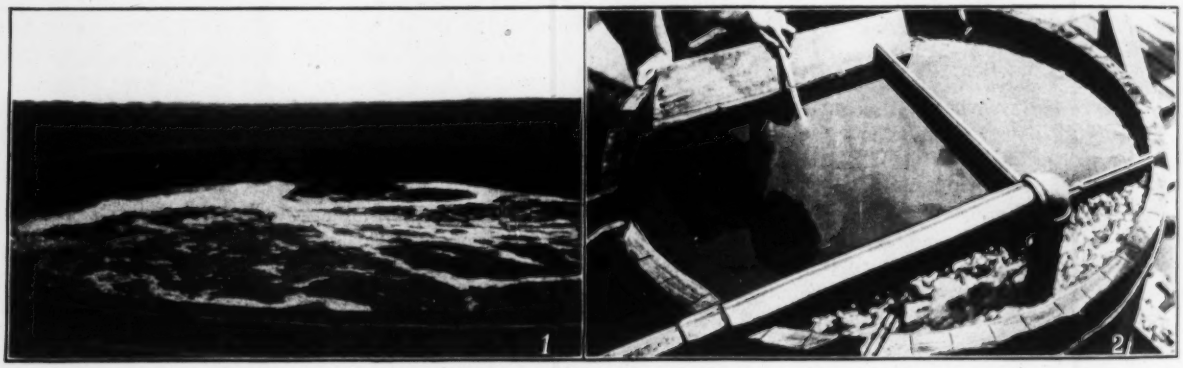
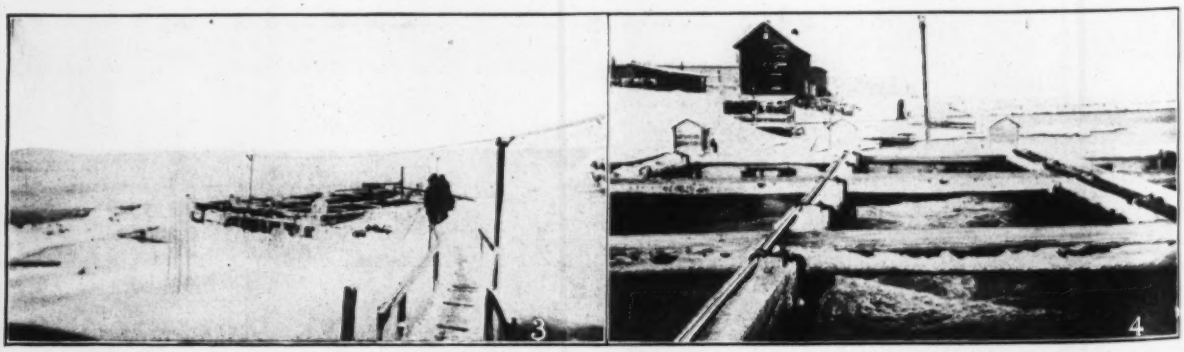


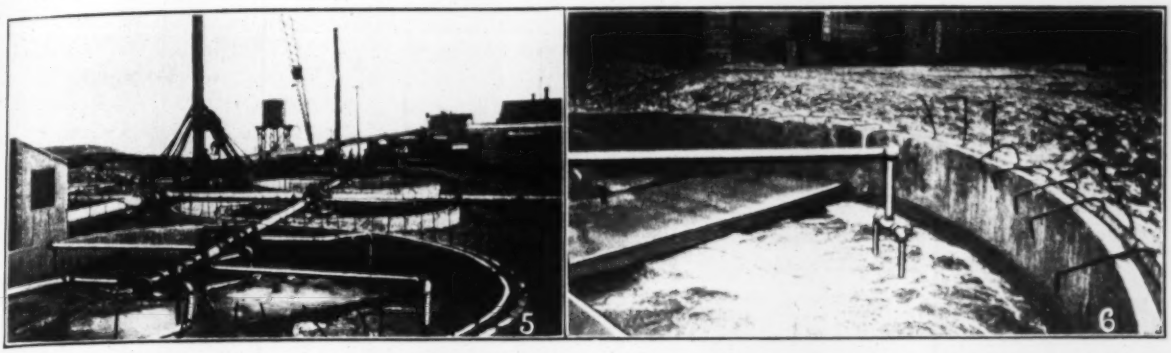
FIGS. 1 AND 2. TWO ACTIVATED-SLUDGE TANKS IN OPERATION IN BROOKLYN BOROUGH, NEW YORK CITY. AUGUST, 1915

Fig. 1—Tank aërator, with air supplied through grid of perforated pipe located 22 ft. below surface of sewage. Compare this surface with surfaces of tanks aërated through porous disks and plates. Fig. 2—Small continuous-flow tank of Imhoff type. The clearness of the settled sewage is indicated by the rule thrust into the treated sewage, the rule being visible to its end. The ebullition in the foreground is in the gas vent, outside the settling chamber



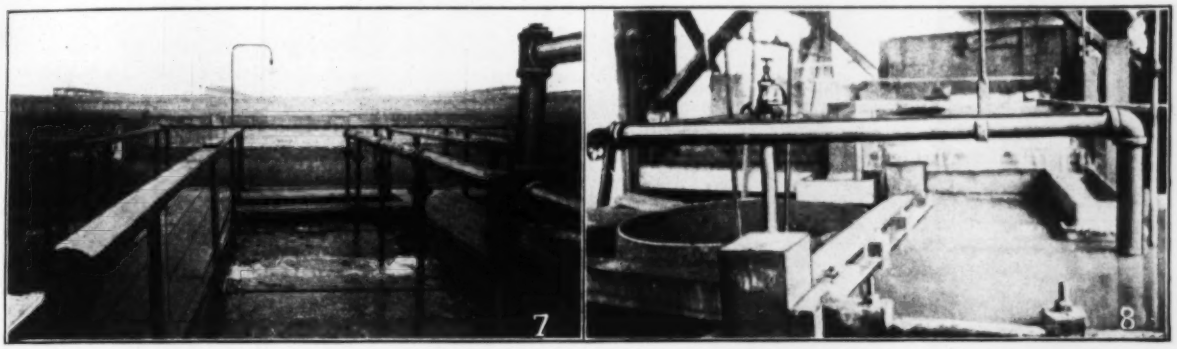
FIGS. 3 AND 4. WINTER VIEWS OF LARGE ACTIVATED-SLUDGE TANKS AT CLEVELAND, OHIO. TAKEN MAR. 22, 1916

Fig. 3—General view of plant, with Lake Erie in background, frozen. Operation of tank not interrupted by cold weather. Fig. 4—Surface of aërating tank. Air supplied through porous plates set in valleys at bottom of tanks



FIGS. 5 AND 6. GENERAL AND NEAR VIEWS OF LARGE NEW ACTIVATED-SLUDGE TANKS, MILWAUKEE, WIS., MAR. 20, 1916

Fig. 5—General view. Air supplied through porous plate. Observe wave on surface in middle foreground. Fig. 6—Near view. Note irregular ebullition as compared with surface of Brooklyn tank (Fig. 1), supplied through grid. The Milwaukee distribution is one of the best observed for the plate diffusers



FIGS. 7 AND 8. TWO INDEPENDENT ACTIVATED-SLUDGE INSTALLATIONS AT CHICAGO, MAR. 21, 1916

Fig. 7—Sanitary district of Chicago. Air supplied through porous plates. One of the best air-distribution results observed. Fig. 8—Armour & Co. plant. Settling tank in foreground; overflow weir behind that

of such importance as to make its employment of questionable advisability. There are some difficulties about the design of the plant which, although troublesome at present, may be met and solved by the ingenious designer, such, for instance, as the best method of air distribution, the size and arrangement of tanks, etc.

Concerning the design of such a plant but little is settled, upon which one can decide his own problem. Every existing plant has its own general design and its personal peculiarities. All agree in being different from the others in essential features; all agree also in giving very different results.

The thing that is giving the greatest trouble is the sludge problem. The production of a highly putrescible sludge in quantities from 15 to 30 cu.yd. per 1,000,000 gal. per day is not to be considered lightly. In a plant provided to treat 10,000,000 gal. there will be 150 to 300 cu.yd. to be disposed of daily. The sludge is very moist, the water content being 97% at Cleveland and 98% at Milwaukee. The sludge possesses a certain value for use as a fertilizer base, but this will vary with the length of aëration and the character of the sewage. In order to be salable it must be dried to a moisture content of 10%, and to accomplish this, without causing a nuisance, at a practicable cost not exceeding the value and fair charge for disposal of the sludge offers a difficulty not yet overcome.

The value of the dried material as fertilizer base is stated to vary from $5 to $20 per ton; but the amount actually secured from drying and selling depends upon many conditions, such as the possibility of storing the dry sludge, transportation facilities, commercial demand, etc., and cannot be predicated on the mere valuable constituents of the dry sludge.

It may be pointed out in this connection that vast quantities of municipal wastes, containing large fertilizer values, are now being unwisely neglected. Only six cities in the United States operate their own garbage-reduction plants, and only 20 more send their garbage to privately owned plants, out of the 199 cities having a population of 30,000 and over; and these produce in the course of a year 160,000 tons of fertilizer out of 1,045,000 tons of garbage. It is estimated by the United States Department of Agriculture that at least eight times more fertilizer might be made from wasted garbage alone, which has to be disposed of and could readily be used for the purpose. The recovery of value from this material is greater than we can ever expect from average dried sewage sludge; and while the garbage is neglected, notwithstanding the profit of working it, what can we expect will be the attitude of the public toward providing expensive fertilizer-recovery plants in connection with sewage disposal?

This is a commercial and practical question, the failure to solve which may render the use of the activated-sludge method impracticable in many places. A more hopeful view may be gained, however, by consideration of methods of reducing the volume of the sludge-making materials by some form of preliminary treatment previous to aëration. The possibility of this is suggested by examination of all the plants studied.

A certain proportion of the suspended solids, possibly as high as 25% to 40%, can readily be removed from the sewage by means of medium-fine screening. The writer

feels certain that it is cheaper in almost every form of sewage-disposal treatment to screen out as much as practicable. It costs less to dry and burn or otherwise dispose of screenings than it does to permit them to remain and increase the expense of sewage treatment and add to the volume of sludge.

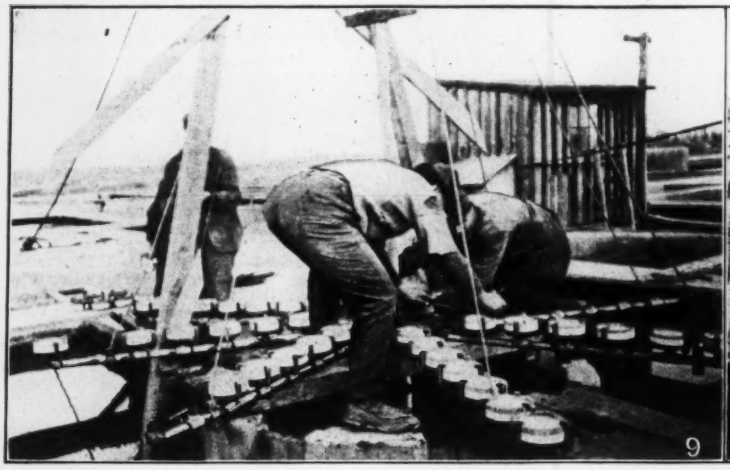
As a preliminary to activation the screen should not be too fine. An aperture less than ½ in. would probably remove material that should be activated, while larger than $\frac{3}{16}$ in. would admit substances that should be treated as screenings.

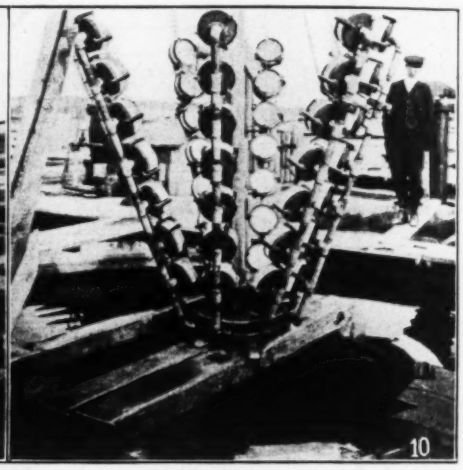
In Brooklyn we are preparing an experimental unit for activated sludge, to continue the work of last year on a much larger scale, and shall treat only sewage that has passed through our new Riensch-Wurl screens. The solids that the screens will remove are shreds of string, pieces of fabric, leather, cotton waste, paper, hairs, bones, bits of wood, corks, orange peel, skins and pieces of vegetables, tea leaves, etc., as well as undisintegrated fecal masses, to attempt the treatment of which by an aëration

to meet. At Milwaukee several forms of presses have been tried. In Cleveland it has been found that screenings from a Riensch-Wurl screen can be readily dried to 30% moisture in a centrifugal drier. The drier employed to take care of screenings from 6,000,000 gal. has a basket only 20 in. in diameter and 10 in. in depth and yet has sufficient capacity to more than do the work. This is to be tried on activated sludge; but unless press drying is resorted to as a preliminary, its success is doubtful. In any case further drying will be necessary to obtain a content of 10% moisture.

It would seem possible to use a press in which canvas bags of proper size to fit the basket of a centrifugal drier are placed in such a way that the sludge, having previously been concentrated by standing in a deep tank, could be allowed to strain through the bags until filled with retained material, the bags after pressure being removed to the centrifugal to complete dewatering.

The Schaefer-ter-Meer drier may prove of service for activated-sludge drying, but it would have to be followed





FIGS. 9 AND 10. AIR-DIFFUSER DISKS FOR ACTIVATED-SLUDGE TANK, BALTIMORE, MD., JAN. 26, 1916
Fig. 9—Putting disks in frame. Fig. 10—Frame and disks closed like umbrella frame, ready to be lowered to bottom of tank, where frame was opened to assume a horizontal position

period of 4 hr. would be useless as well as unfair to the activated-sludge method. In visiting the plants previously mentioned the need of screening the entering sewage was very apparent in every one, as well as in the Brooklyn plant.

Methods of sludge disposal, without going to the expense of drying and recovering the fertilizer value, should be given an extended trial. Our experience in Brooklyn suggests that it would be practicable to digest the sludge, without nuisance, in properly designed separate digestion tanks, the entire process of handling being without exposure to the air. The sludge could be thus rendered as inoffensive as Imhoff sludge and would dry as readily.

The Dixon method of sludge treatment may also be tried, but this is more in the line of fertilizer production. It is now being experimented with in Brooklyn, a demonstration plant having been installed by its promoters.

Dewatering the sludge is a matter of much difficulty and expense. So far no really satisfactory method has been found. One difficulty is the requirement that no more than 10% moisture shall remain in the dry material in order that it may be marketable as a fertilizer base. This is a very hard condition for a sewage-disposal plant

by further drying. Tests made with it at our Jamaica plant show that, operating on sludge containing 91.5% moisture, the dry material had a moisture content of 64.2%. The figures are averages of performance. It must be admitted that the sludge problem has not been solved and is our greatest difficulty.

It was anticipated that difficulty might be experienced from the effect of cold weather on the activated-sludge process. Operation of the plants during the past winter has proved this fear groundless. The specific heat of air is such that but little heat is removed from the sewage. The plant in Cleveland, started the latter part of January, was able to collect sufficient activated sludge for continuous operation in ten days. The loss of heat in the sewage through the plant is only 1° C. The plant is in a very exposed situation on the lake front and, as seen by the writer, was in the midst of ice and snow, with a temperature below freezing. It was apparently unaffected by the cold.

Air-distribution troubles have been pretty general. Wherever porous disks or plates of porous material have been the means of application there has been trouble. In Brooklyn, porous disks were used in one tank, and a

pipe grid was used in another. The result was all in favor of the pipe grid, which after supplying air for aërating a deep sewage tank for 2½ yr. is still in good order and scarcely needs cleaning. The distribution of air, as seen on the surface of the tank contents, is more even and less marked with local ebullition in this tank than in any tank, seen by the writer, in which porous plates are used. The grid should be so designed that it can be drained through an outlet pipe and should have a connection with the city water-supply, if possible, so that it can be flushed out at times. A steam connection, so that steam can be turned on to drive out grease when the tank is empty, would be a good feature and will be tried in Brooklyn. The pipe grid should be so designed that there will be no dead ends. A grid should have a surrounding pipe connecting the outer ends of the cross-pipes, and preferably the air should be supplied through a cross-pipe placed at right angles to the grid pipes. The bottom of the tank should be designed with shallow valleys with sharp slopes, in the lowest part of which the grid pipes are placed, so that no sludge can settle below the air apertures.

It is true that in laboratory work a higher efficiency may be gained for the air by securing very fine bubbles, and there may be a "critical size"; but one must provide such a design that under working conditions, always subject to unforeseen disturbance, the best average effect can be secured. In a working plant the difference in effect between "critical sizes" and the ordinary bubble does not give advantage enough to overweigh the danger of the clogging of very fine porous air distributors. For practical use over a long period the writer believes that the perforated-pipe grid is as good as the porous plate and will give the plant a better average effluent. With the grid the air supply is subject to very small variation in quantity, while with the porous plate great variation is possible from clogging, which even results from microscopic dust carried by the air.

It is possibly for this reason as much as from any other of the reasons assigned that the writer observed that all the plants seen in operation were doing far less than their nominal capacity. The Milwaukee plant, visited Mar. 20 of this year, was said to be treating only 750,000 gal. per day. Its nominal capacity, with 4-hr. aëration period, is more than double this amount. The Cleveland plant, visited Mar. 22, has a nominal capacity, with 4-hr. aëration, of 1,000,000 gal. per day; it was treating only 400,000 gal. per day. The same conditions were found at Chicago, visited Mar. 21. In consequence of air-distribution troubles the Baltimore plant was not working when visited, and a new arrangement of porous disks was being installed.

The volume of air used per volume of sewage in all these plants varied widely, though all were attempting only to obtain an effluent of low stability. Of course, special conditions at the stockyards in Chicago would except them from this comparison. But the sewages of Brooklyn, Cleveland and Milwaukee, on the average, do not differ very widely in character.

In conclusion it must be admitted that the activated-sludge process is not as yet out of the early experimental stage, that as yet none of the problems surrounding it are even fully understood, and all are awaiting further study. No forecast as to its value for sewage treatment on a large scale seems to the writer to be now justified.

Duty Record for Turbine-Driven Centrifugal Pumps

A new high record for the duty of a steam-turbine-driven centrifugal water-works pump has been made at Montreal; a figure of 168.3 million foot-pounds per 1,000 lb. steam (at 140 lb. gage and 100° F. superheat, excluding friction head loss through condenser and piping) was obtained in tests of a geared unit having a daily capacity of 30 million Imperial gallons per 24 hr. against 210-ft. head. The unit was made by the De Laval Steam Turbine Co., Trenton, N. J., and was installed in the low-level station of the City of Montreal. The appended data showing results of tests have been furnished by the manufacturers.

In this station are eight pumps of various types having a total daily capacity of 108 million gallons. The older units are reciprocating machines, but later centrifugals driven by triple-expansion engines were added. The specifications for the new pumps were drawn up by T. W. Lesage, Engineer and Superintendent of water-works, and included the following items:

Brake horsepower of turbine	1,600
Number of stages	14
Speed of turbine, r.p.m.	3,600
Ratio of gear	6 to 1
Diameter, suction and discharge, in.	30
Speed of pump, r.p.m.	600
Pressure head, lb. per sq.in.	85
Suction lift, ft.	5—8
Efficiency of pump	80%
Weight, pump, turbine and gear, lb.	80,000
Floor space, sq.ft.	247
Weight, condenser and auxiliaries, lb.	43,300
Floor space, condenser, sq.ft.	100
Area, condenser, sq.ft.	3,000

The duty was required to cover all losses, including pipe friction, velocity head and steam for auxiliaries (credit allowed for heat returned by feed-water heaters). It was further stipulated that in determining the duty the pumping unit should be credited with the vertical distance from the water in the suction well to the center of the pump shaft, while the discharge pressure, would be measured at the point of connection with the city main, corrected to the elevation of the center of the pump shaft, the pumping unit thus being charged with the friction through the piping, condenser shell, check and gate valves, etc.

It was required that the unit should be tested to its full capacity at the builder's shops before shipment and after installation at Montreal should be run continuously for 15 days of 24 hr. each without shutting down, at the conclusion of which endurance test a duty test of 8 hr. continuous running was to be made. In event of failure to develop the duty guaranteed a deduction of $2,000 was to be made for each million foot-pounds by which the duty should fall short of the stipulated guarantee.

The following figures summarize the results of the final duty test, which was carried out on Oct. 15, 1915:

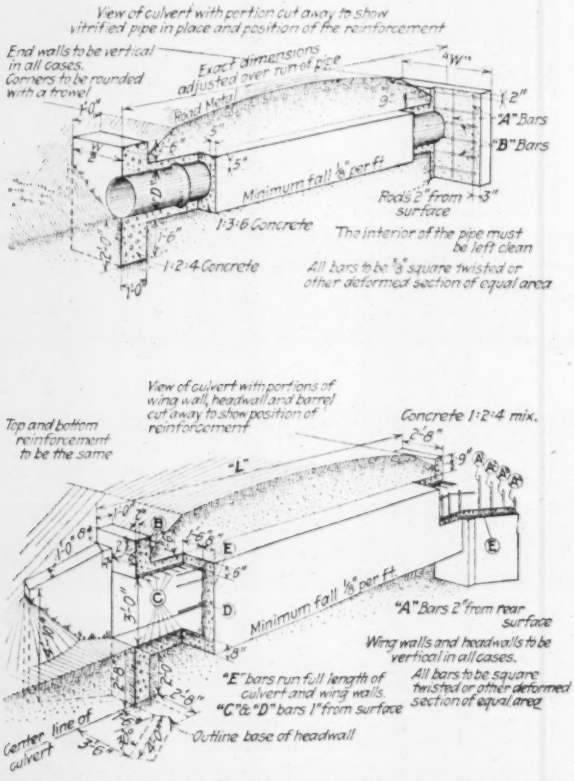
Average water delivered, Imp. gal. per hr.	1,308,808
Corresponding rate per 24 hr.	31,411,292
Average pressure at gage on discharge pipe, ft.	197.274
Average suction lift from water level to center line of pump, ft.	8.6
Total average corrected head, ft.	205.874
Average water horsepower	1,360.85
Steam consumption, corrected for credits, lb. per hr.	17,344
Average absolute steam pressure, lb. per sq.in.	159.7
Average superheat at turbine, deg. F.	63
Steam consumption, corrected to contract conditions, lb. per hr.	16,638
Steam per water horsepower, actual, lb.	12.7
Duty per 1,000 lb. of steam supplied, actual, in million foot-pounds	155.356
Duty, corrected to specified superheat and pressure	162.0
Duty, corrected to superheat and pressure and for condenser and piping friction	168.3

Field and Office

Perspective Working Drawings in Ohio Highway Standards

Perspective representation is used effectively on many of the standard-design sheets of the Ohio Highway Department. The simpler types of structure lend themselves best to this form of representation; no attempt has been made to apply it to complex structures like plate-girder bridges.

Two of these perspective drawings are reproduced herewith, to show the clearness and saving of space which the method secures. It will be understood that below the


View of culvert with portion cut away to show vitrified pipe in place and position of the reinforcement
End walls to be vertical in all cases. Corners to be rounded with a trowel
Exact dimensions adjusted over run of pipe
Road Metal
"A" Bars
"B" Bars
Minimum fall ⅛" per ft
Rods 2" from 3" surface
1:3:6 Concrete
The interior of the pipe must be left clean
1:2:4 Concrete
All bars to be ⅝" square twisted or other deformed section of equal area
View of culvert with portions of wing wall, headwall and barrel cut away to show position of reinforcement
Top and bottom reinforcement to be the same
Concrete 1:2:4 mix.
"L"
Minimum fall ⅛" per ft.
"A" Bars 2" from rear surface
Wing walls and headwalls to be vertical in all cases.
"E" bars run full length of culvert and wing walls.
All bars to be square twisted or other deformed section of equal area
"C" & "D" bars 1" from surface
Center line of culvert
Outline base of headwall

TWO PERSPECTIVE WORKING DRAWINGS USED IN OHIO HIGHWAY DEPARTMENT STANDARDS

Standard tile culvert shown above and standard 3x3-ft. box culvert shown below

sketch, on each sheet, are given notes of instruction and tables of sizes of reinforcement, etc. Thus the sheet is a complete working drawing for a structure called for at a particular location on a road job, except as modified by sketch in the plans for the road. The depth of foundation of headwall (in the standard sheet for the tile culvert shown 2 ft. below invert) is frequently increased to suit the local ground, or in place of the plain headwall a box inlet for the side ditch is shown. In such cases the special sketch sheet gives in simple outline the barrel and headwalls of the culvert, states its length and grade, notes the quantities of materials and shows in detail the part that is to be different from the standard; it further bears the note "Standard Design," to indicate that parts not fully shown are to be built according to the standard sheet for the type of structure in question.

This perspective representation has generally proved satisfactory to the contractors. In one or two instances there has been complaint that it is not as easy to understand as an ordinary working drawing made on rectangular projection. The reader can easily judge for himself how far this complaint is justified.

Tests of Concrete Distributed by Short Chute

Tests to study the question whether spouted concrete is injuriously affected by the process of spouting were made recently by a committee composed of the following: Ernest McCullough, consulting engineer, Chicago; John Wilson, consulting engineer, Duluth, Minn.; G. E. Scott, contracting engineer, Norwalk, Ohio; Ernest Ashton, chemical engineer of Lehigh Portland Cement Co., Allentown, Penn.; A. D. Williams, chief engineer, West Virginia State Road Bureau, Morgantown. The committee acted for the National Conference on Concrete Road Building.

Over 120 samples of concrete were taken, in 6x12-in. test cylinders, from 1:2:3 concrete mixed to various consistencies (stiff to sloppy) and chuted through a 12-ft. chute on a paving mixer, the chute being set at various angles (15° to 25°). The time of mixing was varied from ½ min. to 2 min. The test results (printed in Report of Committee VIII, which may be obtained from J. P. Beck, 208 South LaSalle St. Chicago), show that most of the samples were of very high strength, the crushing strength being 3,500 to 4,000 lb. per sq.in. at 1 mo. age and 5,000 lb. at 2 mo. Hand-mixed specimens, also 1:2:3, gave only 2,950 lb. at 1 mo. and 3,800 lb. at 2 mo. (average of five specimens from separate batches, all figures being close together). Thus the machine-mixed and spouted concrete was much stronger than hand-mixed and hand-placed concrete.

With the machine, times of mixing as low as ½ min. gave lower results. Sloppy consistency generally produced low strength. With a consistency pronounced ideal for general concrete work, the ½-, ¾- and 1½-min. mixtures were recorded as "too stiff to flow in chute," and the 2-min. mixture "had to be pushed down the chute," when the chute was at 20° angle. In one test made with 15° angle the mixture used was much softer and gave 500 lb. lower strength.

Prof. D. A. Abrams, of Lewis Institute, Chicago, tested the specimens. The committee reached the following conclusions: Distributing concrete from the mixer by chute is good, when the method is used properly. The pitch of the chute should be steep enough to deliver concrete of a proper consistency readily; the least angle should be about 20° and the maximum amount of water should be 6 lb. per cu.ft. of loose materials. There is no reason for favoring boom-and-bucket distribution over

chute distribution. When buckets are used, the preferable type is one that dumps by overturning.

With regard to mixing, the committee reported its belief that for roadwork the speed of the mixer drum should not exceed 16 r.p.m., and each batch should have not less than 10 revolutions and not less than 1 min. of mixing. The last recommendation is based not on the strengths found in the tests, but on the observation that when mixing less than 1 min. there was a marked difference between the first and the last concrete of the batch.

Waterproofing Membrane Intact After Extreme Expansion

A notable instance of a waterproofing membrane that remained intact while the masonry beneath cracked and separated is seen in a retaining wall on the Bay Ridge Improvement of the Long Island R.R. at Myrtle Ave. station in Brooklyn, N. Y.

A stairway was built down through a wall, as shown in Fig. 2, an expansion joint being left across the whole cross-section near the edge of a mid-height landing. This work was done in 1912, and the bituminous membrane cap was put on, as seen in Figs. 1 and 2, in January, 1913. The waterproofing was done by the Masonry Waterproofing Co., Brooklyn. By April, 1913, the expansion joint had opened up about 7/8 in., though no leakage was detected. At that time the membrane was examined and found stretched tight as a drumhead over the crack. A strip 7 in. wide and 15 in. long was cut out and peeled down, as shown in Fig. 1. The bituminous compound had adhered to the concrete so that a putty knife had to be used to chop the fabric strip away.

This membrane was made up of cotton-drill sheets 2 ft. square, saturated in a compound blended to secure maximum cohesion and adhesion and laid with 2-in. laps all around. Careful inspection showed that the opening of the expansion joint had been accommodated by slipping of the sheets at the laps—the maximum movement being about 1/8 in. nearest the joint and some slip being appreciable for four sheets back on each side of the joint. After inspection the strip was put back and a new sheet sealed over the spot. The joint was filled with 1:2½ portland-cement grout poured in behind dams after the joint had been raked out as much as possible from the stairways. In October, 1913, the joint was observed to have opened ¼ in. more, but the wall was still dry. It was then regrouted. In November, 1915, there was another opening of ¼ in., but the joint was still dry.

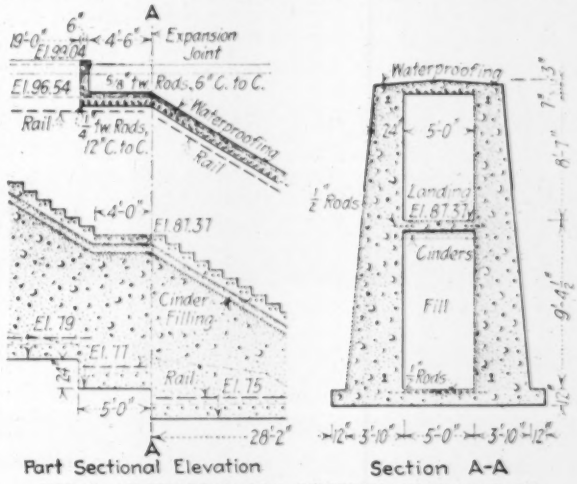


FIG. 2. ELEVATION AND SECTION OF WALLS AT STAIRWAY, MYRTLE AVE. STATION

Lubricated Trunnion Pin for Bascule Bridge

By Charles P. Wiweke*

The main trunnions of a bascule bridge are usually so located that they get scant attention beyond, perhaps, what is given during the yearly overhauling of the structure. Yet it is very important that they be kept lubricated.

*104 Willett St., Albany, N. Y.

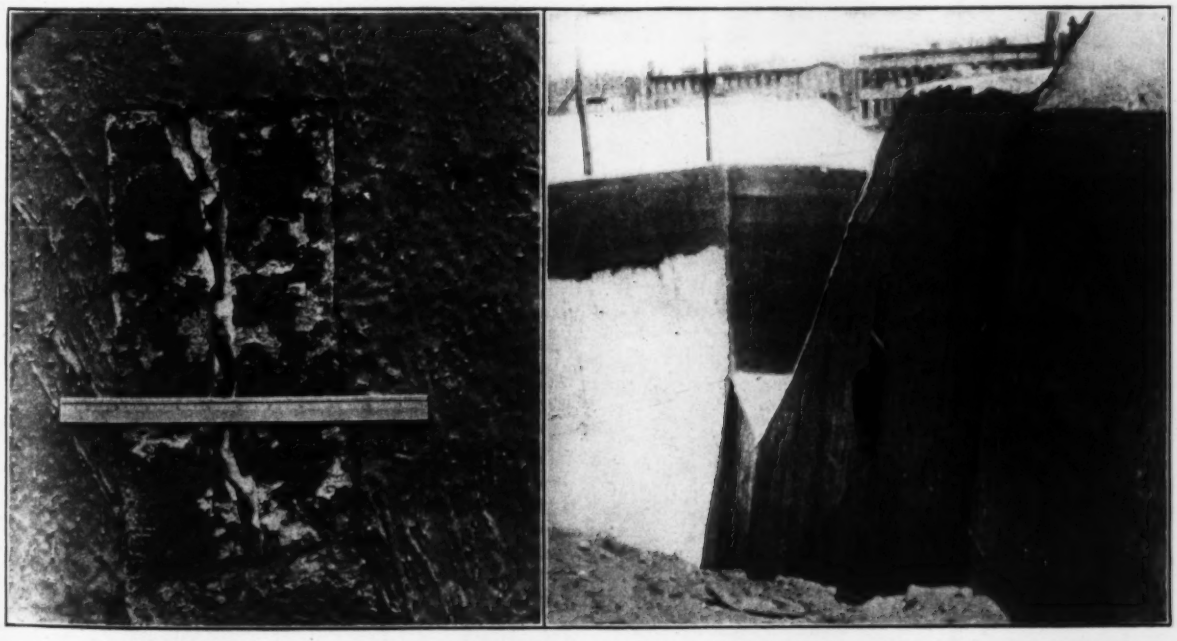
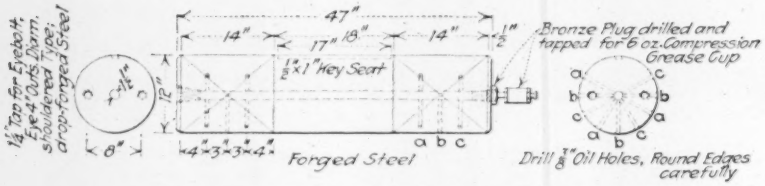


FIG. 1. WATERPROOFING SUBJECTED TO EXPANSION; BAY RIDGE IMPROVEMENT, LONG ISLAND R.R.

The sketch shows a pin with a central hole used as an oil reservoir. The hole is called for in all large pins, in order to make sure of getting a sound pin. The hole being there in any event, plugging the ends and drilling the radial holes convert it into an oil reservoir that will lubricate the bearing all around.



TRUNNION PIN WITH OIL RESERVOIR FOR A BASCULE BRIDGE

The eye-bolts are for ease in handling the pin. It is also worth notice that experience has shown the necessity of securing the pin against endwise motion. The tendency is there, and the pin will creep unless prevented. Ordinarily, several 1-in. setscrews are used.

Practice in Rapid Taping in Montana Mountain Work

By E. E. Thum*

The note from W. H. Rayner in *Engineering News* of Mar. 30, 1916, p. 614, regarding sag and slope diagrams for the steel tape, prompts an expression of methods found very useful for rapid and accurate mineral and legal survey work in the mountains of Montana.

Eliminate the sag correction entirely by making it equal and opposite to the correction for stretch. Formulas for this operation are given in many texts on surveying; it is only necessary to know the modulus of elasticity of the tape and its weight per unit length, when a short table can be quickly computed giving the proper pull for measurements with unsupported lengths varying by 25 ft. This table is recorded in the chainmen's notebooks, but is unconsciously memorized with a day's use.

In rough country a 300-ft. tape is essential. In order that the maximum tension in such a tape be kept under 30 lb., a light narrow band is required. Larger tensions are out of the question for cramped quarters or icy slopes.

In order that the pull may be measured, both head and rear chainmen are provided with spring balances. To grasp the tape at any point in its length, easily, quickly and without injuring the tape by sharp bends, they also carry a small lineman's comealong—a small brass clamp open at the side and built with an eccentric joint that grips tighter the harder you pull.

Measure to nails in all cases. On long shots set line hubs at 300-ft. intervals or on commanding points. In rough or timbered country the instrument points will usually be less than 600 ft. apart, when all measurements can be made to the instrument. On smooth ground measure along the ground (no sag) with the standard pull. On rough ground measure unsupported to the instrument axis. Swing free across large gullies.

Slopes should be taken on all measurements. This can be done with the vertical circle of the transit, sighting to the line hub or to the approximate height of instrument on the chainman's body, in case the measurement is taken to the axis of the transit or to the hub, respectively. A good Abney level in the hands of the head chainman will serve excellently for intermediate shots. Lacking this, set up quickly near every other line hub and measure the vertical angle with the transit both to the rear and ahead.

Correct the inclined measurements to horizontal by multiplying them by the versine of the vertical angle measured. The result is the amount the observed distance exceeds the true horizontal. In case a table of natural versines is not available, subtract the natural cosine of the slope angle from unity. These corrections can usually be figured on a slide rule.

Temperature corrections are liable to be large and hard to compute, using ordinary tapes. Thermometers are rather fragile equipment at best and are continually being broken. Again it is very questionable whether the temperature observed is even a fair indication of the temperature of the tape, especially under conditions such as the following: Sparsely wooded country, soft snow on the ground, bright sun, and air temperature about zero on the shady side, 40 or 50 in the sun. The only practicable way out of such a dilemma is the use of a tape made of "invar," a high-nickel steel whose coefficient of expansion at atmospheric temperatures is so small that it may be disregarded except in the most precise base-line work.

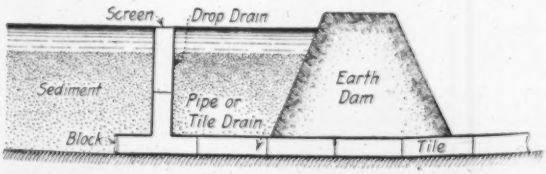
All horizontal angles should be repeated, the true angle regarded as one-half the double-angle measurement. In case the slopes are steep, plunge the instrument and double the outside angle, recording one-half the double angle thus measured as well. By properly averaging the results of the direct and reverse operations, any error in instrumental adjustment is largely eliminated.

Using the foregoing methods, one will be able to make most excellent closures over the worst kind of country at a surprising rate of speed. With practice a party will become quite confident of its work and will run out spurs with every probability of the resulting data being of a high order of merit.

*Assistant Professor of Metallurgy, University of Cincinnati, Cincinnati, Ohio; formerly Civil and Construction Engineer, Anaconda Copper Mining Co.

Sediment for Filling Gullies in Flood-Scoured Ground

In reclaiming and improving lands subject to damage by erosion due to floods one problem is the filling of the gullies in the surface. A method that has been used in Missouri and North Carolina is shown in the accompanying drawing. A bank or dam of earth is placed across the gully, with a line of drain tile or sewer pipe laid beneath it. On the upstream side of the dam this drain



METHOD OF FILLING GULLIES IN ERODED LAND

has a vertical extension. Water flowing down the gully forms a pool in which the sediment due to erosion is deposited, while the comparatively clear water flows away through the drain, as is shown in the accompanying drawing, which is taken from a bulletin (No. 236, February, 1916) issued by the North Carolina Experiment Station at Raleigh, N. C.

There will be a series of dams and drains in the gully; and as the deposit fills in, the dams are raised and the drop drains increased in height. This method does not provide against the erosion of the land by the surface water that finally reaches the gullies, and for this reason the terracing of the surface is recommended in combination with the use of the dams and the drains.

Light Steam Shovel with Scraper Action

The "Keystone" traction excavator is a successful departure in steam-shovel manufacture. It is especially applicable to road grading, and a scoop of special design and action is provided for this service. It can also be adjusted for trenching, through-cutting and side-hill excavation by rearranging interchangeable sheaves and tackle and changing to the proper form of shovel or scoop.

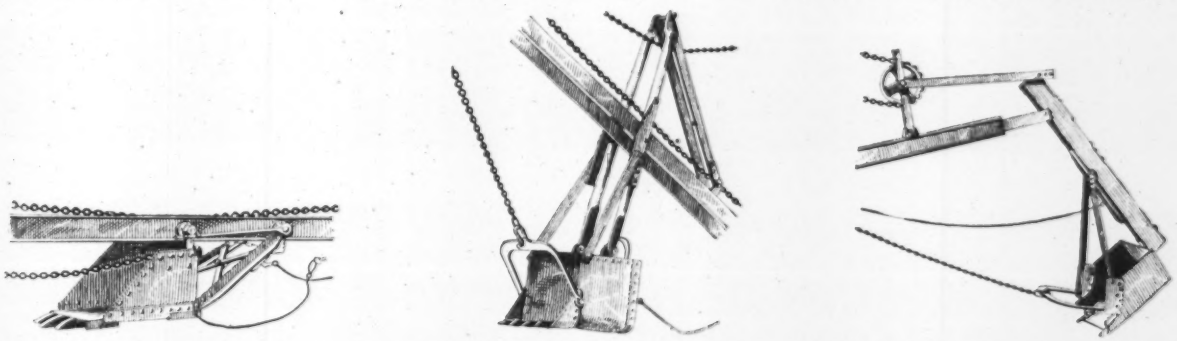


FIG. 1. THE THREE SCOOPS—THE SKIMMER FOR ROAD GRADING, DIPPER FOR REGULAR STEAM-SHOVEL WORK, DITCHER FOR TRENCHING, AS THEY ATTACH TO THE BOOM

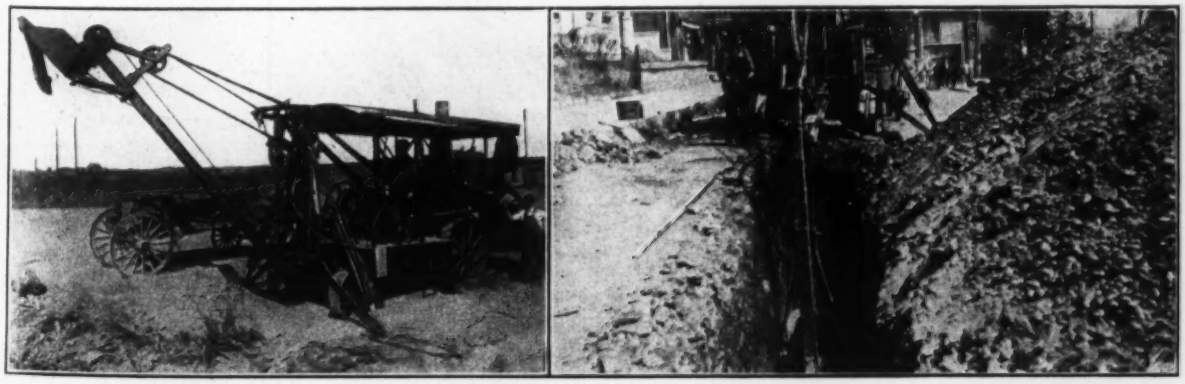
For regular steam-shovel work a dipper scoop is provided, and on this service the shovel will take down a 12-ft. bank. Used as a dirt loader and grader on road work, it can cut from a few inches to 5 or 6 ft. and for this work is fitted with what is termed a skimmer scoop of ½-yd. capacity. As a ditch digger the machine is backed away from, and in line with, the center of the ditch. In fair material it will excavate to a depth of 10 ft., depositing the spoil on either side of the ditch.

The excavator weighs but 19,000 lb. It is self-propelling, having two speeds—of 1 and 3 mi. per hr.—the propulsion machinery being the same as that furnished for many years on the Keystone well-drilling machine. The engine has 8x8-in. cylinders and a link reverse controlled by a rod and hand lever from the operator's platform. The boiler is suitable for either wood or coal, and the water tank holds 75 gal.

The boom, 16 ft. long, made of two 7-in. 15-lb. I-beams, swings through an arc of 180°. The hoisting cable is of ⅝-in. wire rope or cable chain, as preferred, and the sheaves are 16 in. in diameter. The machine is 18x7 ft. in plan (without the boom) and 11 ft. high.

This is a two-man machine. Under ordinary circumstances a single operator can handle it on the road or on the job; but if the wagons arrive steadily enough to keep the shovel in constant operation, a second man will be required to fire the boiler, assist in placing the blocking, etc. The scoop can be filled, raised and dumped in about ½ min. and will fill an ordinary dump-wagon in 2 to 3 min.

To get in position for work, the machine is moved so that the front end is about 6 ft. back from the material to be moved. The boom will then cover the field of operation of the scoop. The rear wheels should be blocked to prevent the machine from being shoved backward as the scoop is forced into the material. The bracing jacks at the front of the machine are then extended until the feet are solidly on the ground, and dogged.



FIGS. 2 AND 3. LEFT—BOOM RAISED TO HIGHEST POINT; HINGED BOTTOM OF SKIMMER SCOOP OPEN. RIGHT—DITCHING AND SIDE-CASTING

To operate the skimmer scoop for highway grading, the scoop is slid back to the inner end of the boom, which is in horizontal position. The hauling-drum lever is thrown forward, and the scoop moves along the boom until filled. The boom and scoop are raised to the height necessary to clear the wagon or dump-car, when the scoop is swung round and dumped. The bottom is thrown back in place and latched by a second pull on the trip line.

When the dipper scoop is used, the machine has to be moved up every 4 or 5 ft. Where the embankment is more than 6 or 7 ft. high, this scoop is more effective than the skimmer.

The ditcher scoop serves for digging in front or on either side of the machine. For trenches up to 44 in. in width the scoops are made of widths to correspond.

The machine is built by the Keystone Driller Co., Beaver Falls, Penn. With complete equipment of tools and fittings, but without scoops or their attachments, it is priced at $2,750.

Wrecking an Old Water Tower

The old wooden tank and water tower shown in process of destruction in the accompanying views was at Dodgeville, Wis. The tower was 60 ft. high, with a spread of about 20 ft. at the base, and was of the old-style 12-post design. The cylindrical wooden tank was about 16x16 ft., of 20,000 gal. capacity.

The wrecking was done with a set of blocks and tackle, a team being attached to the pulling rope. The tank was first pulled off, with tackle attached near the top, as may be seen at the left. Then the tower was pulled over, as shown. It was badly smashed by the fall, so that the wreckage was readily removed.

The Des Moines Bridge and Iron Co., Des Moines, Iowa, did the work, after it had built a 50,000-gal. steel tank with hemispherical bottom on a steel tower 90 ft. high to the balcony. This firm has done similar wrecking in a number of cases where it has built modern steel structures. The foremen have displayed considerable ingenuity in carrying out the work without damage to other property, and in one case the rope was hitched to a switching locomotive.

Irrigation Module Devised for Constant Flow

By Jerome Barieau*

The constant-flow irrigation module shown in the accompanying sketch has been devised by the writer and has been used with great success by the Pacific Gas and Electric Co., San Francisco. It is an inexpensive device, since it consists essentially of a cast-iron base and a number of galvanized sheet-iron cylinders; no container box is required. Patents are pending.

Water enters the small inlet cylinder of the module through a T connecting with a 4- or 6-in. pipe from the irrigation canal. It flows down through the base, up between the weight and float cylinders and out to the consumer through the exit gate.

The float is formed by two cylinders partly telescoped and made air-tight at the top connecting wing, so that air is held in this gasometer above the water surfaces *A* and *B*. Three brackets permit the weight chamber to rest on a flange at the lower end of the inner cylinder of the float; all three cylinders of the float and weight chamber move together.

The large outer cylinder is a casing containing dead water, and it acts as a counterbalance to the water in the float, so that there will be no flow over the fixed inner casing cylinder. In the inlet cylinder is an air chamber connected by a ¼-in. galvanized-iron pipe to the gasometer and acting automatically with the latter—

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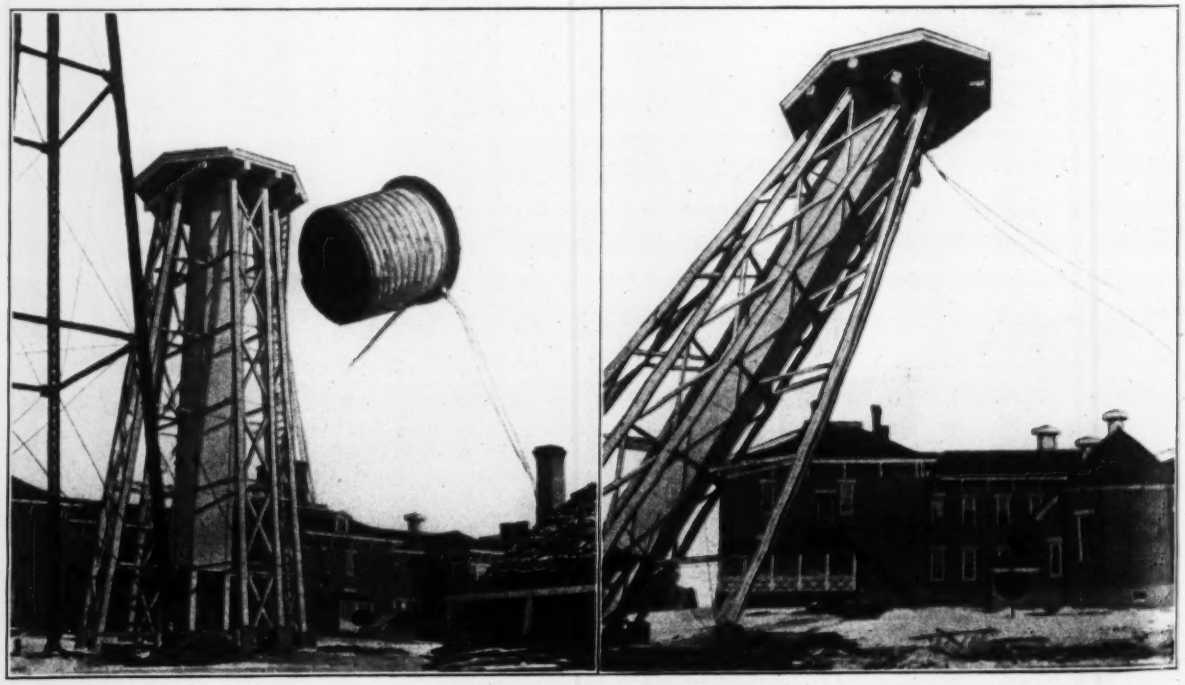
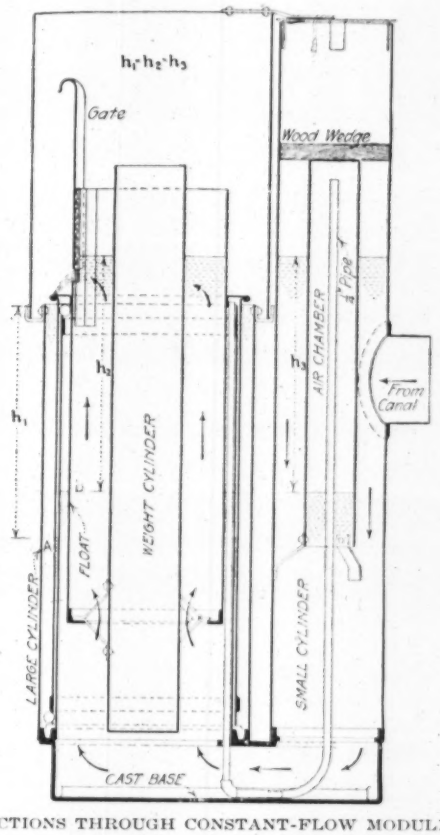


WRECKING AN OLD WOODEN TOWER AT DODGEVILLE, WIS.

each giving or taking air according to the rise or fall of water.

The water surfaces in the inlet cylinder, float and canal are all at the same level. If the level rises, the weight cylinder acts as a float and the gasometer is raised proportionately. But as the gasometer rises, air



SECTIONS THROUGH CONSTANT-FLOW MODULE

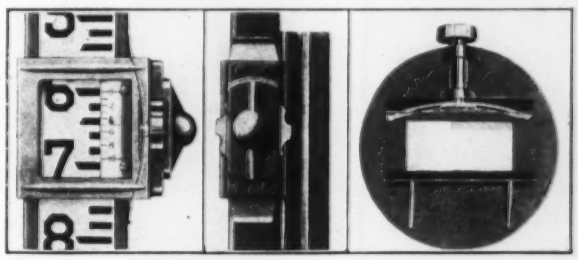
is automatically supplied by the pipe from the air chamber—keeping the air pressure constant in the gasometer. The size of the air chamber is such that the rise in water level supplies the proper quantity of air for the change in the gasometer. The device is designed to fail by expelling air when the outer cylinder of the gasometer rises to the level *A* of the seal water rather than by water going over the fixed inner cylinder.

Instead of the water flowing from an orifice it can just as well flow over the whole or part of the float circumference, thus giving a very small head loss where necessary; in an extreme case the module can be designed to work perfectly as a submerged weir with varying canal depths. Also, where the consumer has a pipe-line connection to the main canal this device can be used and the water automatically stopped whenever the consumer shuts off at the lower end. There is no case in actual practice where this module cannot be used; it also has no limit as to size and capacity. To make it free from meddlers, a hood is mounted over the float on four brackets and padlocked down.

The accuracy is indicated by the fact that no moving parts touch; the float carrying the orifice simply rises and falls in water. Rollers are put on the adjacent cylinders with a free play of ⅛ in. so that in case a cylinder does tip a little it will roll along easily. Experiments have shown that the rollers do not touch except in extreme high water or when the stability of the gasometer is below normal. With an ordinary size of module the head variation over the gasometer orifice never is more than ⅛ in. for a variation of 12 in. in the main canal. The module can be designed for any variation in canal level. If from year to year the consumer changes his demand, he is easily satisfied by merely the alteration in position of the exit gate, as the ordinary size will deliver quantities from nothing up to 20 miners' inches.

NOTES

An Improved Leveling Rod of the Philadelphia type is shown in the accompanying view. The vernier clamp A has the vernier set flush with its face and is held in position by a curved plate spring. A screw with cog-wheel head, shown at B, applies pressure at the center of the spring. This prevents binding and adds to the life of the spring. A cap protects the head of the screw so that it cannot fall out or be broken off. The target clamp C has a similar



DETAILS OF NEW LEVELING ROD

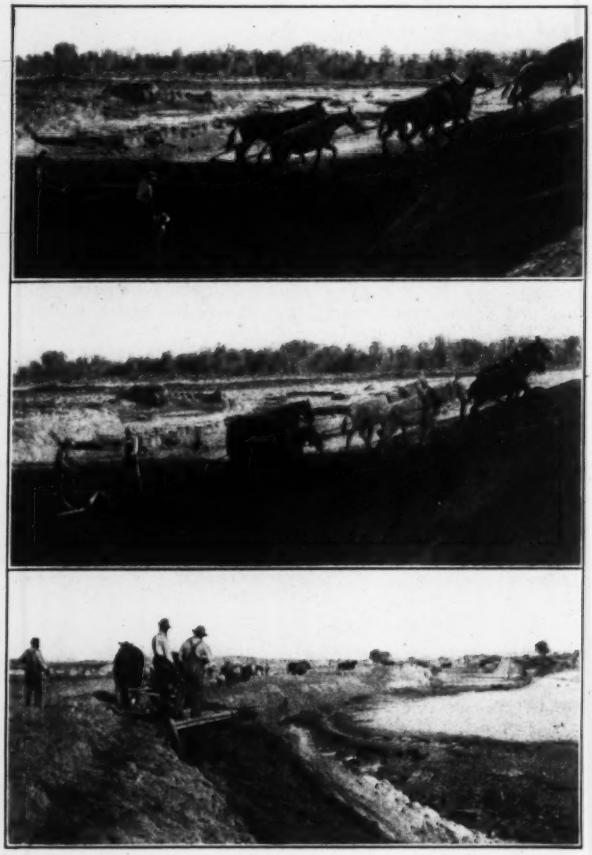
spring and screw arrangement, but the screw has a milled head. The sliding clamp is so designed as to give extra play to allow for expansion due to dampness, but at the same time to avoid a loose fit. The rod is of maple, finished in waterproof varnish and having hard enamel for the target and the background of the figures. The target has a dull finish to eliminate trouble from glare of light, and it has raised dividing lines to give a distinct definition. This rod is built by the Frederic Post Co., Chicago.

Cost of Street Paving in Amsterdam—The street paving of Amsterdam, Netherlands, has been relaid at a cost of 12,250,000 florins ($5,000,000). Cobblestone paving covers 1,100,000 sq.m. (1 sq.m. = 1.196 sq.yd.), costing 5 florins ($2.01) per square meter; brick paving, 2,750,000 sq.m., costing 2 florins ($0.80) per square meter; asphalt, 111,000 sq.m., costing 6.20 florins ($2.49) per square meter; and wood blocks, 38,000 sq.m., costing 12 florins ($4.82) per square meter.

The Relative Value of Central Mixing Plants, as compared with separated local plants, for the mixing of concrete for the New York subway was discussed by Robert Ridgway in a paper before the American Concrete Institute in Chicago. In the case of many of the contracts, notably most of those for the Lexington Ave. section, the contractors preferred to use central mixing plants, which were generally located along the East River, where the material could be brought to them by water, the concrete after mixing being hauled one-half mile or so to the work. Where motor trucks were used, the time consumed in transporting the mixture was not a cause for concern. Some of these trucks had a capacity as large as 4 cu.yd. On one of the sections air jets were used instead of water jets to assist in loosening the concrete from the truck in dumping. On several of the contracts concrete was hauled in horse-drawn trucks from the mixing plant. The time required was long enough to raise the question whether initial set was taking place before the concrete could be placed in the form, and it was necessary at times to reject some of the concrete when it was delayed too long in transit. Because of the trouble from this source the contractors then adopted the plan of mixing the ingredients dry at the central plant and delivering the dry mixture on the street at the work, when water was added and the mixture turned over twice by hand before being placed in the form.

Among the advantages of a central mixing plant are the following: Economy, especially when it is located on the waterfront; a minimum of inconvenience to the public and to residents along the line of the work and more convenient supervision of the whole operation of mixing. In spite of these advantages, however, Mr. Ridgway prefers to have the concrete mixed as close to the work as possible, as he believes that a better quality of concrete is insured when it can be delivered to the form immediately after mixing. On those contracts where the latter method is followed portable mixers are generally used, being moved from place to place as the progress of the work demands. This, of course, means that the street must be temporarily obstructed not only by the mixing plant itself, but by the piled concrete material that must be stored in the vicinity.

Backfilling a Washout on the Grand Canal, Salt River project, United States Reclamation Service, required some unusual earth-handling methods. The washout occurred at a point where the canal was curved out around a knoll and where it came very close to the river bank. The water, being deflected from the canal approximately at right angles into the river, scoured out a channel much wider than the original canal. It was necessary to do considerable backfilling as well as to close the breach, in order to restore the canal to its original prism. As the bottom of the canal had some soggy places, the time-honored methods of moving the earth for the fill with fresnos was not possible. Instead, the outfits shown in the accompanying views were used. First, the scrapers deposited the spoil on the edge of the fill; next, a six-mule plow was



BACKFILLING A WASHOUT ON THE GRAND CANAL, SALT RIVER IRRIGATION PROJECT

Top View—Plow team. Lower Views—Drag team

passed along the edge, followed by a six-mule A-frame of timber, like a road drag. The plow loosened the material, while the A-frame crowded it over the edge of the fill into the ditch. The scheme was admittedly not ideal, but it was about the only way the work could has been handled with the equipment available, which was that ordinarily provided for ditch building—plenty of mules and scrapers. The canal beyond this point is being relocated, cutting through the bluff instead of going around it. The project manager of the Salt River project is W. S. Cone, and the Construction Engineer is Walter Ward, under whose supervision the work was done by day labor.

Pavement Omissions—A peculiar Texas condition is shown in the accompanying illustration of a San Antonio street. The Texas state law guarantees every property owner his homestead; it cannot be taken for any debt or debts that he may incur. The homestead is likewise guaranteed to his widow unencumbered. This law has proved troublesome in the paving programs of nearly every Texas city; for unless the property owner will sign a voluntary lien on his homestead, there is no way in which he can be made to pay his paving assessment. Even such a lien is an encumbrance only if the property is sold, for it cannot be collected by an attachment on the homestead. The ordinary method of procedure is for the city to pay for paving the middle third of the street, leaving the property owner on each side to pay for his third. It is also general practice for the city to leave the collection of the assessments to the paving contractor, who then has to make individual contracts with every owner of abutting property. As the collection of the assessments is generally by instalments, a paving contractor in Texas requires both capital and a business organization. The result is that competition is limited; only the large corporations are ordinarily able to undertake the work, which probably adds at least 10c. per square yard to the cost of all pavements. It often happens that the owner of a homestead refuses to sign a contract or lien with the paving contractor, and then conditions like that illustrated come into existence.

STREET IN SAN ANTONIO, TEX., SHOWING PAVING OMITTED IN FRONT OF HOMESTEADS

Motor Traffic Affects Design of Arterial Highways—A condition has arisen within the last few years which has modified some of the principles regulating the laying out of arterial thoroughfares. It was formerly necessary to obtain such gradients on these main thoroughfares that large loads could easily be conveyed in the ordinary horse-drawn vehicles. The development of motor-driven traffic has considerably lessened the importance of securing very low gradients. It is still true that, for traffic purposes only, level-grade streets are best, and it is still the duty of the engineer to secure as near an approach to such a level grade as may economically be possible. The minimum grade which has heretofore been considered necessary in this city [Seattle] for such thoroughfares is 3%. In the Municipal Plans Report of only five years ago, for instance, an elaborate plan is suggested for cutting down the grade of Stone Way north of Lake Union from the existing rate of 4.7% to 3%. In my judgment the incurring of any expense for such a purpose will never be justified under the new conditions which have arisen since this report was made. With the motor truck the load is not limited by any reasonable grade, as in the case of the horse-drawn vehicle. The steeper gradient simply means the consumption of a greater amount of gasoline; but the central fact remains that the load, however great, is carried along without stoppage. If a team too heavily loaded approaches the steeper grade, it must necessarily stop and unload a portion before it can proceed, or secure additional teams to pull it over the hill. In other words, the rate of grade limits the load. With the motor truck the gears may be changed, but the load is not limited except by the capacity of the truck. I have therefore in the laying out of arterial thoroughfares adopted a rate of 5% as a maximum gradient. The change from a maximum of 3% to a maximum of 5% very greatly increases the ease and facility of locating these streets and makes it possible to obtain them in many cases at far less expense.—1915 report of A. H. Dimock, city engineer, Seattle, Wash.

Editorials

Perspective Often Preferable to Right-Line Projection

Sticking to the iron-clad tradition of right-line projection for working drawings is not always good. The simplest or most effective way to show a structure may be the use of an elementary perspective or isometric or other diagonal projection. Two samples shown by drawings are taken from present-day practice; they demonstrate that it is possible to combine a great deal of detailed and fully dimensioned matter in such a drawing. An example from the practice of 50 years ago was found in the case of the old Lake Shore trainshed illustrated in *Engineering News*, Aug. 20, 1914, pp. 402 and 403. Probably the method was much more common in those days than it is now.

Some skill and ingenuity is desirable—or essential—if perspective representation is to be fully successful. The device of cutting out a corner to show interior structure, as employed in the sketches of the Ohio Highway Department shown on another page, is a case in point, for without this little trick the construction and reinforcement of the headwall would be much less clear. But the necessary skill is not hard to acquire; it only needs some practice. Such practice is well worth while, the more so because its results are permanent, like the knack of skating or swimming.

A somewhat different use of perspective was shown last week (p. 738) in abutment standards of the Michigan Highway Department. The dimensions and working information were given by right-line projection, but a perspective was added to give a clearer understanding of the shape of the abutment. This method obviously is feasible even in case of complicated structures, where it is not possible to give dimensions and details on the perspective itself.

Activated-Sludge Problems

Will the sewage-sludge problem ever be solved? This question is prompted by the very interesting and suggestive observations elsewhere in this issue on the results being achieved and difficulties experienced at no less than six of the notable activated-sludge plants of working-scale size now being operated and studied in various parts of the country. The observations have all the more force because they are made by the engineer in charge of one of the activated-sludge plants included in the survey.

An attractive feature of the activated-sludge process is that the sludge itself is used as a contact medium in place of sand, broken stone or slag to aid in oxidizing the sewage and reducing it to a nonputrefactive state. The sludge itself, however, remains for final disposal. Its water content being high, as Mr. Hammond points out in his article, its final disposal is a problem to be reckoned with. This is all the more true if it is finally going to prove to be feasible to reduce the sludge for use as a fertilizer base, for then its moisture must be reduced to 10%. Mr. Hammond, therefore, makes the very interesting suggestion that preliminary screening for the removal of a portion of the sludge and the consequent reduction in volume of the amount to be treated may be desirable. This possibility is certainly worth the careful consideration being given to it at Brooklyn.

It may prove to be a nice problem to determine, and perhaps one to be determined at each plant—the volume of sludge that can be removed by screening and still leave just enough for satisfactory activation. Very likely there may be some localities where it will be more satisfactory to dispose of the whole volume of sludge after activation rather than to try to reduce the volume by preliminary screening.

However this may turn out, it is a most interesting illustration of the apparently never ending complexity of the sewage-disposal problem. New processes come and go; but notwithstanding their number and the high promise of some of them to be self-contained and all sufficient, sooner or later it has thus far always proved to be the case that if a high degree of treatment is required it is often far more advantageous to combine two or more processes or elements of treatment than to attempt to do all the necessary work with one.

If it proves to be advantageous, in some cases at least, to lessen by screening or otherwise the volume of sludge that gets into the activation tank, may it not in somewhat like fashion yet turn out to be desirable to have an after or finishing process for the effluent from activated-sludge works? It is, or seems to be, true just now that whatever degree of treatment may be required can readily be obtained by activation, but a considerable division of labor here as elsewhere in sewage treatment may yet prove to be well worth while, at least for particular localities.

The activated-sludge process combines clarification, oxidation and bacterial reduction in a single tank or series of tanks. These processes may be carried to almost any degree desired. The great question at issue is that of cost, although there may be various difficulties to contend with besides that of final sludge disposal. Two great elements in cost are sewage-holding or tank capacity and volume of air supply required, the first being dependent on the last and both hinging upon the degree of treatment required to meet the local conditions of any given case. There appears to be no serious difficulty in providing requisite tank capacity, although just what this is and the best size and shape of the tank have not yet been fully determined.

The air supply seems to be the critical matter. Associated with it is the provision of just the right sort of machinery for forcing and distributing or diffusing the air through the sewage.

Judging from Mr. Hammond's observations, by far the most uncertain air question is the one of distribution. It will be noticed with interest, perhaps with surprise by many, that Mr. Hammond is strongly of the opinion

that pipe-grid distribution promises to be far better than distribution through porous plates or disks. Surprise at this may be natural, but Mr. Hammond's opinion has an established basis. For instance, in air-lift pumping, it has been shown that the details of the foot nozzle have not the great effect once contended; if tiny bubbles are released they quickly coalesce and pass upward, growing larger and larger. Why, then, use plates if their chief claim is for more minute air diffusion, especially if they give rise to troubles of their own making? It will be interesting to know the extent to which other observers concur in Mr. Hammond's conclusion in favor of pipe grids.

There are of course other activated-sludge problems than those mentioned. Some of these are interestingly discussed in Mr. Hammond's article, and others must remain for consideration at another time.

Centrifugal Pump Overtakes Triple Expansion

The centrifugal high-duty high-head water-works pump at last, after a few years of sharp competition, has caught up with its rival—the triple-expansion pumping engine—in efficiency of performance. It is hardly more than two years since the centrifugal-pump designers really broke into this field and supplied such units as the two 20,000,000-gal. 145-ft. units for Philadelphia, two 24,000,000-gal. 268-ft. units for Toronto, one 100,000,000-gal. 56-ft. unit for Pittsburgh and perhaps half a dozen more of similar capacities scattered about the country.

Previous to three years ago a duty of 80,000,000 ft.-lb. per 1,000 lb. of steam was a highly creditable performance for a centrifugal-pump unit. It was not a bad record for a reciprocating machine. The 100,000,000-gal. steam-turbine centrifugal unit at Ross station in Pittsburgh jumped up to something like 120,500,000 ft.-lb. Then the Kirtland-station 30,000,000-gal. pump in Cleveland carried the record along up to 152,020,000. Now comes the Montreal 31,000,000-gal installation with a record of 155,356,000 ft.-lb. per 1,000 lb. of steam—and there is no reason to believe that the end is quite yet.

It is interesting to compare this two years' progress with the history of the large high-duty triple-expansion engine with which the centrifugal pump has been competing. In its early days, say 1886, the former held a record duty of about 122,000,000 ft.-lb. per 1,000 lb. of steam. This went up to some 154,000,000 by 1892, to 181,000,000 in 1906 and 195,000,000 in 1909. Probably the best figure yet recorded is 202,629,000 ft.-lb. per 1,000 lb. of steam—made in 1914 by the 20,000,000-gal. Bissells Point triple-expansion engine in St. Louis. However, these last two jumps lose their significance when the superheat of the steam supply is discounted.

For useful comparison of all these modern pumping units the old 1,000 lb. of steam basis is inadequate, due to use of superheated steam, and has been employed here only because the earlier available records are so expressed. To get to a rock-bottom base it is necessary to quote foot-pounds per 1,000,000 B.t.u. On this basis the Bissells Point engine record is 166,719,796 ft.-lb. *and the new Montreal centrifugal performance is 168,300,000 ft.-lb.* Incidentally, the thermal efficiency of this turbine-and-pump unit is about 21.4%, compared with 25% for the best recorded quadruple-expansion engine alone.

What Makes It Rain?

The heavy rainstorm that visited San Diego County, California, on Jan. 27, destroying the Lower Otay dam and doing a vast amount of other damage was without a precedent in the history of that section. As most of our readers are aware, this southwestern corner of the United States has a greater variation in annual rainfall than any other section of the country. A drought continuing over three successive seasons, during which not enough rain fell to produce any material flow in the streams of San Diego County, occurred only a few years ago. The question of a safe water-supply to tide over such long droughts of uncertain duration has long worried San Diego. In all the 20 years since the Lower Otay dam was built there has never been rain enough to fill the reservoir behind it until the recent storm came.

The rains of the past winter were unusually delayed, and there probably was some anxiety lest the entire winter season might pass without additions to the stock of stored water. At any rate it appears that some time before the January storm the City Council of San Diego arranged with a professional "rain maker" to go into the mountains back of the Moreno reservoir (one of the main sources of the city's supply) and there work his incantations or whatever machinery he uses. It appears further that the rain maker was to have a fee of $10,000 if he produced rain enough to fill the reservoir.

Whether the city councilors really believed in the rain maker's power over the clouds or whether they accepted his proposition as a joke, thinking it entirely safe to promise the man $10,000 to fill a reservoir which had never been filled and the water in which would be worth several times that sum to the city if filled, does not appear. However that may be, the rain maker now claims to have done his job; and if anyone believes that his operations produced the storm of Jan. 27, it is clear that he not only did his job, but greatly overdid it.

At last accounts the City Council had refused the rain maker's demand for his $10,000 fee, on the advice of the city's attorney that the contract was only an oral one and therefore illegal and not binding under the city charter. Next time the council lets a contract for rain production it will doubtless be particular to specify the exact number of inches wanted and will require of the contractor a bond to indemnify the city from damages in case the contractor pulls the clouds too hard.

The whole story is a new illustration of the extent of popular ignorance as to the causes of rainfall. Older illustrations are plentiful. Many readers will recall an appropriation by Congress a quarter-century ago to enable an inventor named Dyrenforth to experiment in rain production by firing cannons on the plains of Texas. More recent still are the associations for warding off hailstorms in the Alps by firing cannon and the sending out of a special "rain-making car" to the drought-stricken people of western Kansas by the Rock Island Ry.

The engineer makes more use of rainfall records than the men of any other profession. Much of his work depends for success on the amount of rainfall and is subject to destruction by an excess. In order to make any satisfactory reply to the question whether artificial rain production is a possibility it is needful to know the causes which produce rainfall.

It seems worth while to state here, therefore some of the elementary facts regarding the causes of rainfall which are well known to experts in meteorology, but not so well known to the general public and even to many engineers.

In the minds of most people living in the humid climate of the eastern United States and of western Europe the idea is firmly fixed that the ordinary course of nature is to produce rainfall distributed at fairly regular periods throughout the year. A long-continued drought and a long period of heavy rainfall are alike regarded as abnormal departures from nature's regular course.

But when one goes to the Pacific Coast with the established idea that it is nature's business to keep the streets sprinkled, the farms watered, and the brooks and rivers flowing the year round, he finds this unconscious belief completely upset. In California, nature disclaims all responsibility for the growing crops or the water-supply of cities. She pours rain upon the earth in the winter months—scantily in the south and liberally in the north—but from spring until fall, not a drop of water comes from the sky.

When the Easterner inquires concerning the reason for this strange departure from the beneficent operations of nature to which he has always been accustomed, he learns that the Pacific Coast is a great laboratory where the causes of rainfall, which are a blind mystery to dwellers in the East, are annually demonstrated in a manner too plain to be mistaken.

It is of course evident to everyone that the great original source of rainfall is the ocean. All the water that is discharged by rivers into the ocean has come originally from the ocean in the form of moisture-laden winds. There is some evaporation from land surfaces, but it is very small compared with that from water surfaces. The air over the ocean is always heavily charged with moisture; but as the capacity of air to hold moisture varies greatly with its temperature, the winds blowing over the warm ocean water of the tropics hold much more water than the winds blowing over the cold oceans of northern latitudes.

The key to a clear understanding of the causes of rainfall can be very simply stated: *Wherever moisture-laden winds from the ocean are cooled as they blow over the land, to a degree sufficient to condense the moisture, rain will result.*

Apply this key in a study of the Pacific Coast climate. At the extreme north the warm water of the great Japan current, carrying with it warm winds heavily laden with moisture, follows along the coast of Alaska and British Columbia. In this far northern region the land is of course cold, and the result is heavy fog and frequent rain on the coast and an enormous snowfall on the high mountains just back of the coast, as at the White Pass, for example. Along the coast of British Columbia the mountains are close to the sea, and the annual rainfall reaches 150 in. or more at some places.

As one proceeds farther south, however, a latitude is reached where the land is warmer in summer than the ocean and the winds that blow from it. In the valleys of western Oregon there is seldom rain in summer, although rain and snow fall on the cold summits of the high mountains. The water of the Pacific Ocean all along the coast of Oregon and California, even as far south as San Diego, is very cold, and the winds that blow from it are cold and not as heavily charged with moisture as winds from warm tropical waters. Only in the winter months, therefore, is the land over which these winds blow cool enough to precipitate rain. The farther south one goes, the shorter is the rainy season and the less the average rainfall.

On the coast ranges of northern California there is a very heavy winter rainfall, and the redwood and sequoia forests flourish. In the vicinity of San Francisco the annual precipitation is some 20 in.—varying greatly, however, within short distances, according to altitude and exposure. At Los Angeles the average is 15 in., with a far heavier precipitation in the mountains—at an elevation of 3,000 to 5,000 ft.—only a dozen miles away. At San Diego the average is only 9 in., although here again on the high mountains 40 to 50 mi. back of the coast—at elevations above 5,000 ft.—30 in. of rainfall or more has been recorded. Going still farther south, on the long narrow peninsula of Lower California, although it is surrounded by ocean waters and in a southern latitude, the rainfall is scanty and uncertain even in winter, for even at that season the land is seldom cold enough to condense moisture from the winds that blow over it from the adjacent ocean.

An illustration from the opposite side of the globe is found in the moist winds that sweep over the plains of India from the Indian Ocean. These plains are so heated by the tropical sun that little rain results, and irrigation is necessary for agriculture over vast areas. But when these winds, after passing over the plains, strike the Himalayas, they are suddenly cooled; and the annual rainfall in these Himalayan foothills is as great as that recorded anywhere in the world. In the Nicaraguan isthmus similar conditions prevail.

One of the questions that engineers have spent much time in discussing is whether forests increase the amount of rainfall. The intelligent way to study this matter is to consider whether the presence of a forest can materially increase the cooling effect of the land on a passing moisture-laden wind. The amount of heat received daily from the sun on an acre of land, it must be remembered, will be exactly the same whether the land is forested or bare; and except for the trifling percentage of heat absorbed by the forest in its growth, the total amount of heat given off by radiation and conduction must be the same in each case, although there may be some variation in the distribution of this radiated heat through the 24 hours of the day.

If we seek the causes of such torrential and unprecedented rains descending upon a usually arid region as that which recently fell in southern California or the storm which wrought such destruction at Monterey, Mexico, a few years ago, we must find them in the course of moisture-laden winds from the ocean. In our issue of Jan. 6 appeared a map, prepared by Allen Hazen, showing the variation in annual rainfall in various parts of the United States. As was there shown, the whole United States east of the Rocky Mountains enjoys a fairly regular rainfall, while the Pacific Coast rainfall is irregular.

It is probable that the ultimate reason for this is to be found in the ocean trade winds that sweep across the Atlantic heavily charged with moisture, pass on inland over South America, giving to all the vast area of Brazil

from the coast back to the Andes a profuse and regular rainfall, and in North America sweep northward from the Gulf of Mexico over the entire Mississippi Valley. On the Pacific Coast, as soon as one passes south of British Columbia, where a heavy rainfall is produced by the warm winds that accompany the Japan current, no such regular shoreward sweep of warm ocean winds exist. It is the variable winds of the Pacific Coast, therefore, which produce the variations in its rainfall.

As to the causes of these variations, they are too numerous and complicated to yield to systematic analysis, at least in the present state of scientific knowledge. Such elementary things as the shoreward breeze in summer, when the highly heated land is sending a current of warm air aloft like a huge furnace, one can indeed understand; but more complete information about the ocean currents—of water and of air—is necessary for that broader knowledge on which prediction can be based.

What does seem clear, however, is that until man—this small insect crawling over the earth—can find some means to change the course of the winds of the air and the rivers of the sea, his acts can have little influence on the fall of rain.

Co-operate, But to What End?

The high-motived gathering of engineers at Chicago last week known as the Conference on Coöperation met for the broad purpose of securing coöperation—and nothing more. Those who came to attend wished to coöperate as engineers, somehow; they knew not how. The precise What had not taken form in their minds. They came without tangible purpose, except to coöperate. They went apart with no more definite purpose: To coöperate, somehow, in the future. That is regrettable.

Coöperation is good when it has a useful purpose. It is not in itself a purpose. Conceding all due respect to the earnest optimism of the conferees, it remains true that coöperation alone and unvitalized is an empty husk. By all means coöperate, but to what end? Let the end be apprehended clearly and made known!

The men of the conference were moved by strong and true motives—that is certain. They felt doubtless that there is need for a new school, a professional regeneration quite different from tinkering with existing formalism.

We engineers are in the grip of the times, and they are times of change. The unrest of shifting conditions has stirred us. We feel troubles coming to add to troubles already upon us. The individual who turns to his technical societies for counsel and help finds these societies static and supine, not to say torpid. Possibly Professor Newell and his coöperators were actuated by appreciation of these facts.

It is true, we engineers all—or most of us—are ensnared in the same perplexities. If there is today a greater degree of misunderstanding than ever before between engineers and engineers, and between engineers and laymen—especially those who shape our government—this unfortunate state affects us all. We may as well come together, either to mourn jointly, which is vain, or to plan unitedly for reconstructive action within and without the profession. There is logical basis for coöperation, if purpose backs the coöperation.

The forces that brought about the conference are a symptom of the period. Symptoms are of use only for diagnosis; unless employed in locating the seat of the trouble they are of no service. The Chicago group failed to reach a diagnosis. In meeting for mere abstract coöperation it emphasized the symptom without getting nearer to diagnosis or proper curative treatment.

Is it possible that we need an engineering organization that shall be the individual engineer's society, whose main care shall be the lone individual devotee of the engineering profession? The lack of influence and power of the profession in the aggregate may be simply the resultant of the weakness and helplessness of each individual one of its members. If this is the case, then to strengthen the profession we must strengthen and help the individual.

How far have existing coöperative movements—that is to say, the present societies—helped and strengthened the engineer? There are the honor societies and the work societies; the publication societies, which record and educate; the social societies, which entertain; the commercial-aid societies, which promote and regulate industries and incidentally protect the public and save waste of money. None of these have given more than trifling help to the individual engineer. He is in these societies nothing more than a pawn. He should be—or might be—the king, the whole object of the game. The society that shall exist only by, for and to the individual engineer has yet to be created. Is it possible? Is it desirable?

As the world advances, so also, it may be assumed, does the engineer advance. The most optimistic view of this advance, however, cannot fail to notice much that is the very opposite of advance. Complications of many different kinds arise to obstruct the activities of engineers, injure the good repute of the profession and make the individual's professional existence more precarious. These complications will not take care of themselves. A leave-alone policy is a suicidal one for the engineering community to pursue. It must take up each case and grapple with the difficulties.

The past year—to go no farther back—has brought specific examples of serious trouble in the engineer's existence and work in quite different sections of the country. The East, the Mississippi Valley and the Coast have all had their bad cases, and some of these are pending even today. They are the large matters, as legislative over-riding of the engineer's claim to existence and recognition, destruction of the business basis of technical work by introduction of dispensary methods, engineering negligence in large matters to the discredit of the profession, usurpation of important technical functions by administrative officers to the injury of the public's and the engineers' interests, and the like. Smaller matters of the same and other kinds number legion. All have been left untouched—yes, have been deliberately ignored—by the existing societies of engineers. And all of them are beyond the power of the individual engineer to combat unless he has the support of a broadly conceived coöperating body that makes his interests its own.

It cannot be impossible to focus the scattered motives and purposes in the Coöperation Conference into a strong, directed program. The moving spirits in the enterprise are in a position to achieve this result.

Letters to the Editor

Validity of the Pile Formula

Sir—Referring to Mr. Thompson's letter under the title "Pile Formula Misinterpreted," in your Mar. 2 issue, permit me to suggest, without any intention of questioning the well-known value of the *Engineering News* formula, that the impression conveyed (implying that results by this formula are actual) may be very misleading in cases where one is not familiar with the possible variation. In this connection Professor Baker, in his "Treatise on Masonry Construction," demonstrates that under certain conditions the formula gives infinity when solved for load capacity.

Mr. Wellington, who devised the formula, pointed out that an increased resistance or decreased set of the pile per blow, resulting from an interval of rest, would develop increased skin friction due to earth settlement around the pile, and to compensate for this at the moment of impact he provided the constant c in his formula. Use of a constant to meet the widely differing earth textures and pressures and their consequent differing mobility involves an apparent uncertainty in the results obtained.

The true value of this formula will be appreciated most fully when the ease with which it can be equated with an actual load test is known. It is not unusual for building regulations to require a test load, and specifications frequently call for one or more. These, however, are not generally carried to the point that would establish the real factor of safety involved, which should be done if the same known stability that is required in the superstructure is to be maintained; and it is certainly no less important to have this exactness in the foundations than in the construction they support.

In the following example I have used required load capacity, by which means very accurate results are obtained; but very close results may be secured by assuming a load capacity less than the required one, whereby very heavy test loads are avoided, and then following the method outlined. It should be kept in mind that skin friction will not be fully developed until some time after driving; also that in driving concrete piles several methods more or less disturb the earth friction, by the withdrawal of driving forms after desired penetration is obtained. In some cases of concrete-pile driving the use of an enlarged point greatly reduces the friction while driving. In these instances the apparent greater amount of driving energy used to displace earth at the point will give higher load capacity when the earth friction is developed by a period of rest than where no such enlargement is involved. The time allowed for this development of skin friction will naturally vary according to conditions, but ordinarily a week is amply sufficient.

As an example, let it be assumed that the formula has been solved for penetration to support a load of 50 tons, using a steam hammer with ram weighing 5,000 lb. and normal stroke of 42 in., the result being four blows to an inch set. The constant c is here taken at 0.1, as usual with the Wellington formula when using a steam hammer.

Now a test pile should be driven until the mean of the sets for a number of blows, when the penetration has been at a uniformly decreasing rate, agrees with the foregoing solutions of the formula—namely, four blows to the inch.

Let it be assumed that, under test, settlement starts with a load of 300,000 lb. (Observe that, as generally used, the formula is intended to give a factor of safety of 6, because if 12 times the weight of the ram were used instead of 2, the load capacity given would be ultimate.) Accordingly, the test shows the factor of safety to be less than was intended by the formula. The formula is now to be solved for the new factor of safety or, more simply, for the actual value of the quantity to take the place of 12, after which the factor of safety is plainly accessible, as follows:

$$300{,}000 = \frac{f \times 5{,}000 \times 3.5}{0.25 + 0.1} \qquad \text{or } f = 6$$

Substituting this value for 12 in the formula and equating with the ultimate load capacity required under the formula, the following results:

$$600{,}000 = \frac{6 \times 5{,}000 \times 3.5}{s + 0.1} \qquad \text{or } s = 0.075$$

or required penetration equals $^3/_{40}$ in., or $^3/_8$ in. to 5 blows.

It will readily be seen that by this method actual physical conditions are made to govern the load capacity rather than leaving it dependent upon the uncertainty of calculation as governed by empirical formulas. It will be found that the same method can be applied to other formulas, but with more or less complex mathematical work, the absence of which is always desirable.

The assumed load causing settlement was taken at 300,000 lb. in the given example to make the working of the equation plain at a glance; but it should be remembered that in practice this quantity may be made up of various figures.

CLARENCE S. HOWELL.
550 West 174th St., New York City, Mar. 11, 1916.

Is Development Invention?

Sir—In *Engineering News*, Feb. 17, 1916, there appeared an editorial which contained the following paragraphs:

> To most engineers engaged in reinforced-concrete construction it seems exceedingly strange that some of the patents on reinforced-concrete construction should ever have been issued by the Patent Office and stranger still that these patents should have been upheld by the courts. The same thing is true of a number of other patents that interfere with the free work of engineers in design and construction, such as some of the patents on sewage disposal and on road construction.
>
> The position of engineers with regard to the class of patents referred to is that the patents are not on a real invention, but on a particular way of doing something; and they believe further that the state of the art when the patent was issued was such that the patents should be declared void by the courts for lack of novelty.

You made it plain that, in your opinion, patents interfere with free work and that they are not patents on invention at all, but more on the way of doing a thing. Can't you look at this more broadly?

Every once in a while a new and better way of doing an old thing is developed. Traced back, this better way is usually the product of hard, sustained, original effort. In practically every field of commerce and industry society recognizes and rewards such efforts by granting to the developer the exclusive right to the development for a limited number of years. This privilege, granted as a patent, acts not only to encourage original effort, but also enables the patentee to enlist capital for the development of his idea, so that it may be of use to society.

Such is the case in practically every field of industrial endeavor. Applying the same principle to engineering and construction—where the operation is in big units, where the operation cannot be one of individual production and sale—what protection and encouragement can we offer engineers for really working to develop new ideas, new and better ways of doing things?

Take our own case, for instance. We were concrete engineers, designers and erectors of reinforced concrete. In 1906 the Cleveland Furnace Co. needed 1,000 ft. of dock on the Cuyahoga River. Our first plan for this dock, prepared at the company's request, followed accepted practice in dock design, practically a heavy mass-concrete buttress, pile supported and tied back into the shore with iron rods. The cost was estimated at $65 per lineal foot. At this price there was nothing doing. It was put up to us to get a good dock for less money. We analyzed our problem and found that we had to meet the following conditions:

1. We must build a dock wall in such a way that it would not interfere with the natural flow of the water and the bed of the water way.

2. This dock wall must be so constructed as to resist heavy strains from the ships that would come in contact with its outer edge and moor at the dock. Then, too, it must resist the heavy impact thrusts of a loaded iron-ore boat that might strike it.

3. The dock wall must carry heavy loads without tending to slide out into the water.

Reinforced concrete offers permanent low-cost construction, strong without mass, fireproof, rustproof, rotproof.

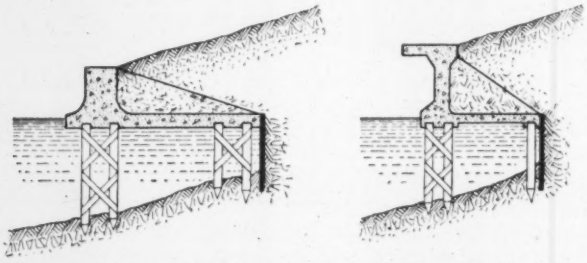


Fig. 1—Original sketch, 1906. Fig. 2—Final sketch, 1906

FIGS. 1 AND 2. FIRST AND FINAL DOCK WALLS OF CLEVELAND DOCK ENGINEERING CO.

We had specialized in reinforced concrete and usually saw things in terms of that material.

We went at this problem as thoroughly as we could. The technical libraries were combed for all the information on dock construction we could get. Finally, out of the mass of preliminary sketches and studies we evolved a different structure, what seemed to us to be a fundamentally new idea in dock design and construction.

The accompanying sketches show how this idea grew. Fig. 1 is the first definite study. The idea was to make the fill take the place of the mass concrete and to tie the dock back into the land by a reinforced-concrete floor.

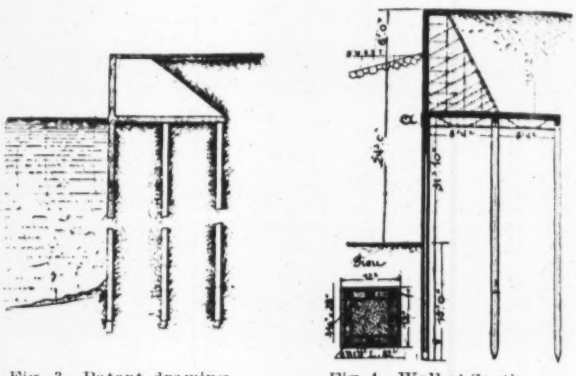


Fig. 3—Patent drawing, 1897 Fig. 4—Wall at Southampton, 1898

FIGS. 3 AND 4. HENNEBIQUE PATENTED DOCK WALL

Leaving out mention of several intervening studies, we finally arrived at a design about like that shown in Fig. 2.

This study developed a great horizontal girder to withstand impact thrust. The dock wall was essentially a giant I-beam with the lower flange on the shore side extended back indefinitely to a tight wall on the shore. The web and upper flange were braced by heavy buttresses 14 ft. on centers. The piling required was minimum, the floor of the river was unobstructed, a tight wall at the shore edge kept the fill dry and the greater the load the greater the stability of the dock wall. The cost of this wall, as originally submitted in an informal proposal, was about $23 per foot, about one-third of the original mass-concrete design that followed accepted standards.

So far—so good. Our design looked good from an engineering and from a financial viewpoint. But it was a new departure, an original development. Before our work was accepted, we had to build at our risk a 30-ft. test section. This was loaded with 600,000 lb. of pig iron. The load was concentrated in 4 sq.ft.—an area 2x2 ft. The settlement of the dock wall under this load was practically nil. The thing was a success. We had developed a new and a less costly way of building docks, a better way apparently.

There were some changes in the conditions—loads were increased and the concrete in the floor made heavier, with additional reinforcing steel, bringing the cost of the dock up to $28.40 per lineal foot. The 1,000 ft. of dock was completed in 1907. It has given satisfactory service every day since. The cost for upkeep has been practically nil.

Now, in view of the rather sweeping statements in your editorial that patents on reinforced-concrete construction are not real inventions and that they interfere with the free work of engineers just let me ask you what there is under the conditions which you apparently advocate to encourage original work on the part of the engineer. If we had been mechanics and our office a machine shop, if we had been chemists and our office a laboratory, the product of our earnest original effort might have been a unit or a definite process defined by set formulas. As it

was, our engineering office was our laboratory; the building site was our experiment station. We developed new methods, accomplishing better ways of doing a thing. Our work and the work of countless other engineers along similar lines have been just as true inventions as if they had been carried on with test tubes and scales.

We want to draw a distinction here and not try sweepingly to defend all reinforced-concrete patents, for many of them, just like many patents in any field, have been, as you say, entirely unjustified, for they have not been the result of honest invention, honestly developed. Isn't it true, though, that to a great extent all patents cover a way of doing a thing? Why should not designs prepared under and protected by patents be just as tangible a salable article as a piece of patented electrical equipment?

We believe that it would be much better for society as a whole to encourage by patent protection more efficient development of engineering and construction methods. In its best sense isn't a patent a trust, a trust from all the people to an individual? This trust should carry with it the moral obligation to use that patent for the good of the people, reserving a fair reward for effort, ability and inventive genius. As a patentee an engineer becomes essentially the trustee of a newer, a better, a less costly way of accomplishing a certain result. The patentee further becomes responsible for the proper development and application of this method. What would be everybody's business is nobody's business, and patent protection in the last analysis is simply a way of making one man responsible, holding him responsible and giving him every encouragement and aid in developing the better method.

Engineering News, instead of confining itself to destructive criticisms of existing conditions, might well see the situation in its broader aspects and help constructively to work out conditions which will in some way encourage original work, protect and reward the engineer who does original work.

J. D. CAREY,
Cleveland Dock Engineering Co.

Cleveland, Ohio, Mar. 27, 1916.

[In answer to the essential criticisms of Mr. Carey, criticisms which seem to be in nowise justified by the editorial paragraphs quoted, we can only repeat that

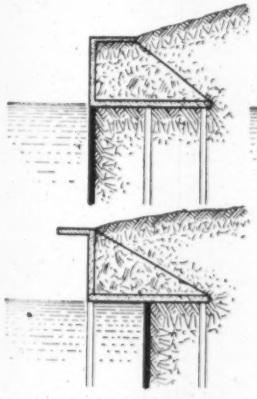


FIG. 5. COMPARISON OF HENNEBIQUE AND CLEVELAND WALLS

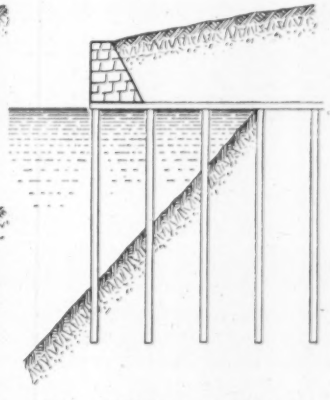


FIG. 6. TYPICAL MASONRY DOCK WALL OVER WATER

invention is necessary to a patent. Development work is taken into account when invention is assured or in doubt, but one cannot secure the monopoly rights in a method or device by study, tests, development or promotion, however arduous and lengthy, if the method or device is assuredly not original to the promoter.

It is in this particular that most of the reinforced-concrete structural patents are subject to criticism. In the decade from 1895 to 1905 a group of European engineers and contractors were developing on the Continent elaborate systems of reinforced concrete at a time when American engineers were practically ignorant of the exist-

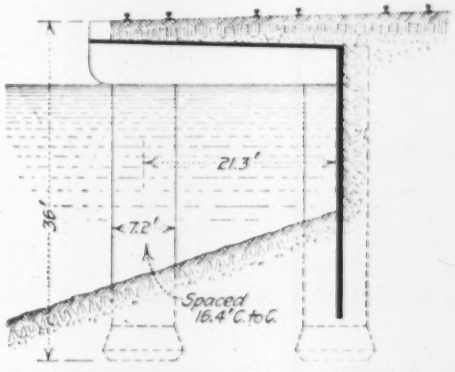


FIG. 7. DOCK WALL AT YMUIDEN, HOLLAND, BUILT BEFORE 1904

ence of such a material. The record of European achievement is fairly complete in foreign texts, so much so, in fact, that practically every American structure, though honestly thought to be novel by its supposed inventor, can be duplicated in French and German literature of one to two decades ago. Those that cannot be so duplicated can generally be shown to be but the result of an orderly process of design possible to any technically trained man. The existence of a previous similar design in any publication is a legal bar to a patent; the question of what is an orderly process of design and what is invention must be left in a specific case to the judgment of the court.

The dock-wall patent held by Mr. Carey's company (United States Patent No. 1,089,405) is a very good illustration of all these arguments. We do not propose to investigate the legality or technical value of that patent. It has already been upheld in the one lower court into which it has been brought, and the structure which it describes is by no means common. But Mr. Carey's letter gives rather a false impression of the addition to engineering science made by his company in its development of the dock wall for the Cleveland Furnace Co. and overemphasizes the novelty of the structure.

In 1897 François Hennebique received a British patent (10,203[97]) on "an improvement in piles, quays and retaining walls" in which appeared the drawing shown in Fig. 3. In 1898 the wall illustrated in Fig. 4 was built, after this patented design, at Southampton, England. This wall embodies every feature of the Cleveland wall except that of extension over the water. Whether such an extension warrants a patent only a court can determine, but the two sketches (Fig. 5) show clearly that Mr. Carey's engineers in their study of the wall were up against a problem in design rather than in invention. By moving the tight wall of sheet piles back from the face of the wall the upper, or Hennebique, wall becomes the lower, or Cleveland, wall in its essentials. Anything else in the later wall contains nothing beyond the elements of design.

Furthermore, the extension over the water was not new. Dock and quay walls of the type shown in Fig. 6 are of

very long standing. The difference between that wall and the one in Fig. 2 is merely one of material. The courts are not united as to whether in reinforced concrete the use of another material constitutes invention.

Even direct anticipation of the Cleveland wall can be found. The drawing in Fig. 7 is a reproduction from a paper read before the International Engineering Congress at St. Louis in 1904 and is sketched from a drawing in "Transactions" of the American Society of Civil Engineers, Vol. 54, A, 1905. It is a wall at Ymuiden, Holland, and possesses all the fundamentals of the Cleveland wall —that is, pile rows in the water supporting an earth-loaded deck extending back to a tight wall that retains the bank. It is of reinforced concrete.

All this does not pretend to be an exhaustive inquiry into the validity of the Cleveland Dock Engineering Co.'s patent rights. So far as we know, that company is more interested in designing and building structures than it is in collecting royalties—which is more than can be said of some structural patentees. But it does explain why engineers resent some claims of structural patentees.—Editor.]

Fire-Resistive Construction Being Developed

Sir—I was particularly interested in reading the timely and logical editorial in *Engineering News* of Apr. 20, 1916, p. 461, under the title "Incombustible Construction" because of its direct relation to two distinct lines of work upon which I am engaged. The first of these is a pamphlet which I have been preparing during the past year, dealing with fire-resistive construction and fire protection for dwellings. I expect to have this ready to issue in about three weeks, and I shall be interested in having your comments upon my method of treating the subject. The second activity to which I refer is that of the work of two committees upon fire-resistive construction—one in the National Fire Protection Association and the other in the American Society for Testing Materials. These committees, of which I happen to be chairman, are working along somewhat similar lines, though the latter committee deals only with standards for test requirements. The former committee has a membership of 17 experienced, practical and very active workers. They are architects, engineers and insurance men, all of whom have had years of training in the actual doing of things; and I may say that I never have worked with a more interested and conscientious body of men. This committee has adopted the principle of recognizing three grades of fire-resistive materials and construction, and following the plan of the British Fire Prevention Committee such materials or construction when properly employed would render "full," "partial" or "temporary" protection for the specific construction.

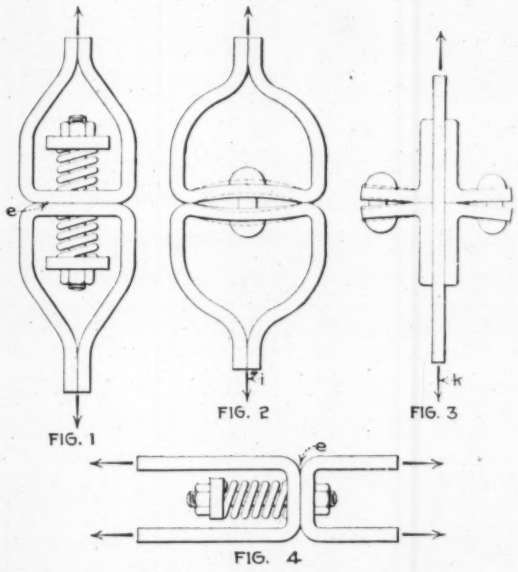
In harmony with this idea of recognizing different grades of fire-resistive construction the Committee on Fireproof Construction in the American Society for Testing Materials has recently accepted the same principle and in its future work will undertake to establish standards of tests for each grade. In order to secure the best results and avoid duplication or complication, in the work, an endeavor will be made to secure coöperation between the two committees.

I thought you might be interested in knowing that such work is in progress, since it is in line with the views expressed in the editorial previously referred to.

IRA H. WOOLSON
Consulting Engineer, National Board of Fire Underwriters.
New York City, Apr. 21, 1916.

Why Initial Tension in Rivets Is Not Serious

Sir—In your issue of Feb. 17, 1916, Jacob M. Friedland gives an analysis of stresses in rivets used in direct tension and apparently finds that tension tending to separate the parts adds very materially to initial tension on rivet heads. Mr. Friedland ridicules the statement quoted in your issue of July 22, 1915, from my book "Steel Designing," "A little analysis will show that



SKETCHES SHOWING HOW SPRING ACTION PREVENTS INCREASE OF INITIAL STRESS

pulling on the head of a rivet already in stress due to shrinkage does not increase the stress on the rivet, but relieves the pressure on the plates, unless the added tension exceeds that already on the rivet."

The analysis is simply this: In Figs. 1 and 4 there is no added tension on the bolt until the surfaces at e are separated, since the springs are not shortened; that is, until the reactions on these surfaces are exceeded or, in other words, until the original tension on the bolt is exceeded by the applied forces.

Mr. Friedland's analysis is at fault, because he assumes a rivet driven through a perfectly solid piece of metal. Rivets in reality hold together two or more pieces of metal which do not fit perfectly on one another. Their tendency to separate acts like the springs of Figs. 1 and 4, as illustrated in Figs. 2 and 3. The amount of this spring in the plates is so large in comparison with the almost infinitesimal thinning of the plate due to compression that the latter can safely be neglected.

It is conceded that if each head of a rivet were taken hold of by a pair of forceps, the increased tension would

be that exerted by the forceps; and if the tension could be applied by thin plates immediately under both heads of a rivet, a large increase in tension would result. But this is not the nature of structural details. A tension detail is usually only a part of a larger detail. The actual tension applied is usually local on a few rivets, while the resistance is general in the member to which attachment is made. Such detail corresponds to Fig. 4.

EDWARD GODFREY.

Monongahela Bank Building, Pittsburgh, Penn., Mar. 16, 1916.

Beware of the Dog!

Sir—Referring to the article in *Engineering News*, Mar. 30, 1916, on the collapse of the pony-truss bridge at Johnstown, Penn., I have had occasion several times to examine highway bridges in which the bottom chords and lower ends of diagonals had rusted out and have concluded beyond a doubt that the eating away of the members is caused by the use of the bridge by dogs as a water-closet. From the diagram with the article referred to, it can be noted that the drip of urine striking member U_1L_2 would fall on the bottom chord directly under and might cause the break there.

We recently repaired a foot bridge for the Botany Worsted Mills at Passaic, N. J., where the evidence against the dogs was unmistakable.

The remedy would seem to be to put up a plank guard that would present a smooth surface about 18 in. high on each side of the truss.

E. G. TROWBRIDGE,
Engineer, Passaic Structural Steel Co.

Paterson, N. J., Apr. 6, 1916.

Laws of Sound in Auditoriums

Sir—The acoustic properties of a building are popularly supposed to be the result of mere chance. This supposition, founded on ignorance, doubtless accounts for many beautiful public buildings put up at large expense turning out to be acoustic disappointments and worse.

The voice of a speaker in the auditorium of the Chamber of Commerce in one of our Middle West cities sounded like a voice in a sepulcher because of sound vibration, until the walls of the auditorium were covered with a sound-wave absorbing material. A great church fared but little better. Quite recently a chapel, an architectural jewel set ideally in the edge of a city park, turned out so bad acoustically that but 70% of the words of the speaker could be heard. It is impossible to listen with enjoyment to an address in a convention hall in a city on the Pacific Coast, because of sound vibrations, due probably to defective interior design.

An amusing incident caused by poor acoustics occurred during a xylophone solo in a concert held in the convocation hall of the University of Illinois. The orchestra leader heard the echo louder than the instrument itself and beat time to the echo. The echoes have since been reduced by wall hangings.

Notable among buildings having excellent acoustics is the Hill auditorium at the University of Michigan, seating some 5,000 persons. The new Boston opera house, built after consultation with experts, is an equally fine example of the application of the laws of sound to architecture. The Mormon Tabernacle at Salt Lake City, holding 8,000 comfortably, has long been famed as the place where a pin may be heard drop at a distance of 200 ft. The acoustics of this auditorium was a piece of good fortune.

Next to architects, engineers ought to know and tell the public that the laws of sound as applied to auditoriums are now so well understood that the acoustic properties of any structure can be definitely determined before a single stone is laid. It is the contention of eminent physicists who have made a study of the subject for two decades that with very little additional expenditure the structure may be designed so that both speaker and music may be heard without effort. If builders could be brought to give heed to architectural acoustics, just as they give attention to strength, fireproofing and similar features considered necessary, there would be no need for suffering acoustic disappointments.

Lexington, Ky., Mar. 19, 1916. D. P. CLEVENS.

[From Prof. Dayton C. Miller, Department of Physics, Case School of Applied Science, Cleveland, Ohio, we learn that in his opinion the most important useful published information on the acoustics of auditoriums is by Prof. W. C. Sabine, of Harvard University, in "The American Architect," Vol. 68 (1900), pages 3, 19, 35 and 43 and Vol. 104 (1913), pages 257 to 279. The earlier articles deal with reverberation and the later one with echoes. Another useful reference is to a pamphlet of 32 pages, "Acoustics of Auditoriums," by Prof. F. R. Watson, in Bulletin 73 of the Engineering Experiment Station of the University of Illinois. This pamphlet contains an extensive bibliography of the subject.—Editor.]

NOTES AND QUERIES

The Needles Bridge Across the Colorado River, between Arizona and California, described in "Engineering News," Apr. 6, 1916, p. 672, was fabricated by the Kansas City Structural Steel Co., not the Kansas City Bridge Co., as stated in that article.

Cost of Cement Testing—In the article with the foregoing title, by Frank H. Carter, published in "Engineering News" of Mar. 9, 1916, p. 471, in the table of "Cost of Apparatus" the item "1 three-section gage mold, $9.60" should be corrected to read "2 three-section gage molds, $19.20," making the total of the table $219.52. "Cost per barrel" should also be changed from "4.20c. to read "4.39c."

A $2,000,000 Damage Suit brought by Memphis, Tenn., against the St. Francis Levee Board for overflow claimed to have been caused by the raising of levees near Memphis has been denied on demurrer by the United States District Court at Little Rock, Ark. The court held that the levees were intended to be permanent and that the Levee Board, the Memphis Bridge Co. and various railroads that were made parties to the suit were justified in raising the levees to a height sufficient to protect the property behind them.

East River Tunnels Show No Movement—Engineers of the Public Service Commission for the First District have just reported the result of an inspection of the south tube of the Battery-Joralemon St. subway tunnel under the East River. The inspection was made to ascertain the extent of change, if any, in the position of the tube since the time of its completion in 1908. Careful observations were made, and it was found that during the period of eight years in which this tube has been in daily operation there has been absolutely no settlement. Other observations showed that there had been no movement whatever in a lateral direction. Examination of the lining of the tube showed that the leakage, which has always been slight, has materially decreased during the period of operation. The engineers will make a similar inspection of the north tube of the same tunnel within a short time.—Public Service Commission, New York, Weekly Bulletin.

Should Engineering Societies Pass on Public Questions?

By Hugh J. Duffield*

A short time ago a reinforced-concrete structure was being built in a certain city under the supervision of that city's engineer. Rerolled steel, employed as the reinforcing material, was objected to by one of the city aldermen, who brought the matter to the notice of the council. The city engineer was asked to explain. The argument fast degenerated to the see-saw order, and a deadlock resulted. The papers then took a lively interest in the matter, and last of all that Colossus of astute intelligence—the man-in-the-street—began to furbish up some of the minor parts of his subconscious stratum.

When a deadlock is established in a controversy, one of the contending parties is very apt to undertake hasty action. Otherwise, complete collapse results. In this particular case the council, instead of taking the matter in hand and obtaining a report on the dispute by some competent person, collapsed.

What next happened was to the writer incomprehensible. An engineering society, uninvited, informed the council that it would be pleased to go into the matter, its services to be given free. The old adage, "Beware of entering into a quarrel," etc., had no terrors for the society. It did not occur to the members that they were exposing themselves to a rebuff in case the council awakened to a sense of its responsibility and again took the matter into its own hands.

This incident brings up the question, Have our engineering societies the right to assume the rôle of adjudicator on all subjects of an engineering nature? The writer wishes, if possible, to ascertain on what authority some individuals have assumed to pass upon engineering matters and then branded their findings with the name of an engineering society. In looking through the constitutions of engineering societies it is difficult to find any laws or rules that clothe the members with judicial authority. Neither has the writer ever heard of any unwritten law or custom bearing on the subject. From this he concludes that the members of our societies never intended that their names should be used in public investigations such as that just cited.

No matter how high sounding our societies' titles may be, we should never lose sight of the fact that these associations are composed of fallible men. Our societies generally recognize this fact, and for this reason they have not included in their plan of organization any provision for investigations of a public nature. As an illustration of the statement that engineering societies are composed of fallible men, the writer asked one of the executives of the society that proposed the investigation referred to what his views were on the subject. This gentleman said that he did not care two straws whether any reinforcing was used in the structure or not! This statement is analogous to that of a baker who informs you that he can make currant bread without currants.

When a society intrudes in such a manner, we naturally ask ourselves, What is this being done for? It is said that there is never a good action done but that there is a small grain of bad in it. The truth of this saying can be seen on a moment's reflection. Did the society offer its services with the intention of placing its decision in the category of "no higher appeal," or was there some extraneous consideration?

If the intention was to place the finding of the society above the opinion of the individual, then the society is curtailing the freedom of the profession. If the intention was to allay the public's fear concerning the material under discussion and if the finding was given with respect to this, then the interference of the society was most harmful. Such a decision would have an influence not measured by the engineering ability of the investigators at all, but measured solely by the good or bad judgment of the men composing the committee. Nevertheless, the committee's decision, being announced as an action of the society, would have with the public a weight that it otherwise would not have. If engineering societies are going to interfere when and where they think proper, what will be the state of mind of the private practitioner? He will never know when he may be brought to account.

Engineering has long passed the stage of mere algebraic formulas. We are no longer dealing only with the x's and the y's; other elements, often very difficult to estimate, have entered into the calculation. They may take the form of expediency or they may be cost figures or they may come under some other head. These other elements have under present conditions a strong influence on our engineering calculations. They are often the controlling considerations. In other words, they are functions of our engineering problem and will often determine the success or failure of a scheme. Our engineering societies, judging from their constitutions, are not concerned with anything outside engineering science, so the harmonizing of this science with general advancement should be left with the private practitioner. For these reasons the writer believes that our societies should not take upon themselves the rôle of "courts of appeal."

*Consulting Engineer, 309 Beveridge Building, Calgary, Canada.

Portable Washer for Aggregate

The simple and portable washer shown in the accompanying illustration is intended especially for cleaning and grading material at small concreting plants or on small jobs where the washing must be done near the work.

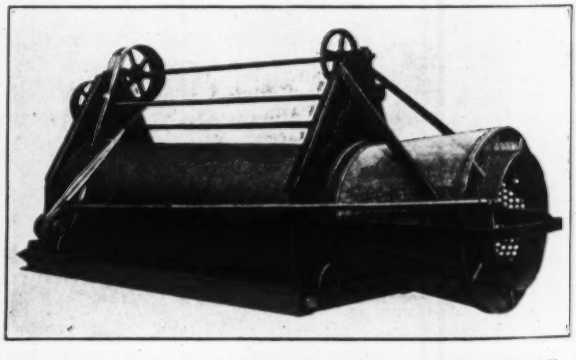


FIG. 1. PORTABLE WASHER FITTED WITH ROTARY SCREEN

The machine may be placed under a platform having a trap or hopper, so that the material can be delivered directly into it from scrapers or wagons. Fig. 2 gives the construction, and Fig. 1 shows one of the machines with a double-cylinder rotary screen attached.

The washer consists of a steel drum about 30 in. in diameter and 8 ft. long, having cast-iron heads, which rest on rollers. The drum is revolved by a sprocket chain that passes around one of the drum heads and over a pinion geared to a shaft which may be belted to a 2-hp. engine or motor. The drum runs at about 6 r.p.m. To

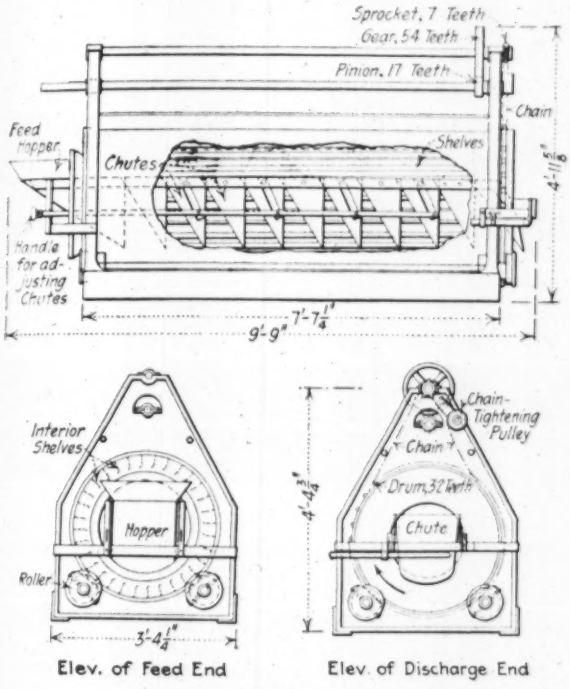


FIG. 2. PORTABLE WASHER FOR CONCRETE MATERIAL. Stocker Concrete Material Co.

the shell of the drum are riveted horizontal angles to which steel plates, or shelves, are attached. Within it also is a series of inclined chutes of spiral form. These are adjustable and can be shifted to any desired angle, according to whether the material contains much or little foreign matter and must be passed through slowly or rapidly.

The drum is partly filled with water, which enters at one end. The gravel is delivered to a feed hopper (at the opposite end from the water feed) and falls to the bottom of the drum. The horizontal ribs in the drum carry the gravel up until it drops into the first chute, by which it is delivered a little farther forward and dropped into the water, to be again carried up and dropped into the next chute. As the gravel moves forward, it meets cleaner water; and by the time it reaches the end of the drum the washing is completed. The washed product may be delivered to a screen attached to the drum, as in Fig. 1, or to a conveyor or storage hopper.

The washer is mounted on a frame 3½x10 ft. and weighs about 2,000 lb. complete. Its capacity is 50 to 60 yd. per 10-hr. day, with a water supply of 10 to 15 gal. per min. It can be fitted with a rotary pump, if desired. It is used on contract work and at gravel pits or stone quarries, also for cleaning the sand at water-filtering plants. Larger machines, handling 200 to 1,800 cu.yd. per day, are built for service at large concrete and gravel plants where the material is delivered to storage bins. These machines are built by the Stocker Concrete Material Washer Co., Highland, Ill.

Competition for Designs for Railway Camps

Adequate and sanitary housing accommodation for men engaged on railway construction and maintenance work is considered by the National Americanization Committee, of New York, as one important means of conserving the supply of unskilled labor and promoting a higher standard of living among the foreign-born workmen. With this in view it has instituted a competition of designs for substitutes for the old box-cars frequently used in housing construction gangs. The committee points out that men who have lived for several months in a construction camp where old and crowded box-cars are the only dwellings and where plumbing, drainage and sanitary conveniences are not provided are not likely to be in condition at the end of the season to face a hard winter in city factory work. Further, many of these men are immigrants, and ordinary camp conditions teach them low standards of living, which they follow when they return to the cities. The purpose of the committee is to conserve the strength and energy of the men and to promote among them an American standard of living.

The specifications covering the competition state that the proposed camp-car outfit should permit of flexibility with regard to the number of men to be accommodated both with eating and sleeping facilities. Consideration will be given to economy of space, arrangements for clothing and cubic air-space capacity. It is assumed that there will be provided a site with spur track for the cars, a well or other supply of water, and old passenger cars (50 ft. long exclusive of platforms) having all seats, lamps and other movable equipment removed. The competition, however, also allows designs of new cars constructed specially for camp service.

The bunk cars should be so equipped that suitable units will afford sleeping accommodations for gangs of different sizes. Ordinarily such gangs are in multiples of 20. One or more eating cars must be provided. The designs must cover heating, ventilation, means for frequent fumigation and for making the cars proof against vermin and flies. Adequate toilets must be shown, at least 150 ft. from the cars, with provision for making them flyproof and for the use of deodorants. Receptacles must be provided for kitchen waste. Drainage of the site must be provided and the system described.

The drawings required include a general plan of the camp and plans and sections of the cars. Three prices are offered: $300, $200 and $100. Designs will be received until June 1. They will be submitted to a jury composed as follows: R. S. Parsons, Chief Engineer, Erie R.R.; James B. Brady, Vice-President, Standard Steel Car Co.; George A. Cullen, Passenger Traffic Manager, Delaware, Lackawanna & Western R.R.; Francis A. Kellor (formerly Chief of New York State Bureau of Industries and Immigration); Dr. Andrew J. Provost, Lederle Laboratories. Information as to the details of the competition may be obtained from the National Americanization Committee, 18 W. 34th St., New York.

Electric Power Required for the recent Panama-Pacific Exposition had a maximum peak of 8,200 kw. This came shortly after the exposition opened on Feb. 20, 1915. During the exposition proper the total energy required was 15,986,085 kw.-hr.; including the pre- and post-exposition periods, the total amounts to 18,321,000 kw.-hr. The maximum daily draft was 80,000 kw.-hr., which cost $320,200.

News of the Engineering World

Federal Road Appropriations Unlikely This Year

Federal aid to highway construction was sidetracked in the Senate on Apr. 21, after the bill making appropriations for such construction had been under consideration by the Senate for three days. The House passed by a large majority several weeks ago the Shackelford bill appropriating $25,000,000 for Federal aid to state road construction. The Senate committee amended the Shackelford bill by striking it out entirely and framing a new measure appropriating $5,000,000 for the year ending June 30, 1917; $10,000,000 for the following year and thus increasing by annual increments of $5,000,000 to an appropriation of $25,000,000 in the year ending June 30, 1921.

This money was to be expended on improvements of rural post roads, defined as "any public road over which the United States mails are or might be transported," with the exception of streets and roads in towns of 2,500 or more population where the houses average closer together than 200 ft. The construction of these roads was to be in charge of the State Highway Departments of the several states, and the Federal Government was to contribute not more than 50% of the cost of improving the roads, approve plans and specifications for the improvement and inspect the work to see that it was done in accordance with the plans. A large number of senators from the West and South favored the bill, but the opposition was successful in preventing a vote on it.

Local Sections of National Engineering Societies

Whether by chance or intent, proof positive of coöperation among engineering societies was afforded within a week of the Conference on Engineering Coöperation, held in Chicago Apr. 13 and 14. Reference is made to a discussion of the relations between national engineering societies and their local sections, which was held at the rooms of the American Society of Civil Engineers on Apr. 19 and was participated in by representatives of that society and of the electrical, mechanical and mining national organizations.

The discussion was opened by Charles Warren Hunt, secretary of the American Society of Civil Engineers. Mr. Hunt stated that the first definite proposition for local sections was taken up by the American Society of Civil Engineers in March, 1905, when measures were instituted by the Board of Direction to get the opinions of three or more members located in each of a number of different cities as to the advisability of section organization. Sections were organized in Kansas City, San Francisco and Memphis in 1905, but little or nothing has been heard from the Kansas City or Memphis sections. The San Francisco section has been very useful. In 1908 the Colorado Association (as these American Society sections are called) was organized with headquarters at Denver. At present there are 15 local associations of members.

In January, 1915, a proposition for district organization arose. A recent ballot of the society participated in by some 3,100 members showed a majority in favor of district organizations.

Following the remarks by Secretary Hunt, a letter from President Corthell was read. He suggested a central or national conference committee and various local conference committees of representatives of engineering societies. He also favored bringing engineers not members of any of the societies into conference.

Speaking for the American Institute of Electrical Engineers, Paul M. Lincoln, past-president, stated that its movement for the establishment of sections was begun in 1892. The first section was formed in Chicago in 1893. There are now 32 sections, besides 53 student branches. Stress has been laid upon coöperation between the local sections of the institute and other engineering bodies in the same city.

The American Society of Mechanical Engineers, said President D. M. Jacobus, now has 15 local sections. He stated further that during his presidency he hoped to visit nearly all, if not all, the sections. He added that engineers must get over the idea of antagonism and must coöperate.

The American Institute of Mining Engineers, according to Past-President W. L. Saunders, adopted the section plan five years ago and now has 15 sections. Mr. Saunders has promised to go to Reno, Nev., to be present at the organization of a new section at that point in a few days.

Representatives of a half-dozen local associations of the American Society of Civil Engineers were called upon by Vice-President Clemens Herschel, chairman of the evening, for remarks. Prof. Charles T. Marx, Palo Alto, Calif., felt sure that the San Francisco Association had brought engineers into more public notice and had made better feeling among the engineers themselves.

John F. Coleman, New Orleans, outlined a scheme of coöperation among the engineering societies, both national and local, and also of coöperation between members and nonmembers of engineering societies.

Frank G. Jonah, St. Louis, said that no papers were read before the St. Louis Association of Members of the American Society of Civil Engineers. He said that association takes its turn with other local sections of national societies in presenting papers at the Engineers Club of St. Louis, with a membership of some 500.

Daniel Bontecou, Kansas City, Mo., said that the Kansas City Association of Members of the American Society of Civil Engineers was, as has already been stated, first in the field, but it was still-born. He had about reached the conclusion that local organizations should confine their efforts to local matter—an opinion which was expressed by some of the other speakers as well.

Prof. George F. Swain, Cambridge, Mass., remarked that they were all members of one profession and not of several and could accomplish the most by cooperation. He had often thought of what would be the best way of organizing the engineering profession if it were not already organized. His conclusion was that a single society of American engineers, with sections, would have been the best plan.

Herbert S. Crocker, Denver, said the Denver Association had been very successful in getting members acquainted with one another and with one another's work. Its greatest difficulty is that of expense. The $2 annual dues are too small to enable the association to accomplish much, and the parent society does not rebate from annual dues to it in order to help support the local section.

At the suggestion of Secretary Hunt, John Bogart, who was secretary of the American Society of Civil Engineers before any of the other national engineering societies except the Mining Engineers was formed, was called upon. Mr. Bogart said he favored local sections. He agreed with Professor Swain as to one great engineering society being the ideal and wished that there had been one great all-embracing national engineering society.

Excluding Trash, Roots and Grease from Sewers

How to lessen sewer stoppages was one of the leading subjects discussed at the first district meeting of the newly organized New Jersey Sewage-Works Association, held at Plainfield, N. J., on Apr. 18.

Stoppages have been noticeably reduced at Atlantic City, said Frederick T. Parker, who is carrying on an educational campaign. The means adopted to this end was the insertion of printed matter with all bills sent out. Somewhat similar experience is reported from another city, where circulars have been distributed, bringing home to householders the fact that upon them finally comes the extra expense of sewer maintenance due to their carelessness in admitting material that would stop sewers. In still another city troublesome stoppage has been reduced by sending bills for the labor involved in removing stoppages, accompanied by photographs of the trash removed.

At Riverside a trap similar to a grease trap, but with a netting over its outlet, has been used to catch stockings and towels that have been started on their way to the street sewer.

Coming now to the subject of grease in sewers, Mr. Parker stated that Atlantic City passed an ordinance requiring the installation of grease traps on every house connection, but that it has not been possible to enforce the ordinance. (It should be mentioned that the sewerage system of Atlantic City is owned and operated by the Atlantic City Sewerage Co.) Mr. Parker stated that records from an average cottage in Atlantic City, housing six or seven people, show a collection of 1½ bbl. of grease per year. If all houses and hotels had grease traps, the 10,000 bbl. of grease could be collected per year. The company has considered making an attempt to enforce the ordinance and letting a contract for the collection of the grease.

The question as to the possibility of removing roots from sewer pipes by means of chemicals led to considerable discussion. It was the consensus of opinion that, whatever means might be taken to remove roots, the pipe would be continually clogged by new growths unless the pipes were taken up and relaid with bituminous joints. Both poplar and willow trees were scored. One member reported that an educational campaign had resulted in voluntary cutting down of all poplar trees by the citizens, but another stated that the mere mention of cutting down such trees in his town had been met with so much protest, including the threat of court action, that the project had been abandoned. I. Z. Collings, Collingswood, N. J., said that the life of a house connection in a yard containing a weeping willow tree was only one year.

Amending Constitution of Civil Engineers

To guide them in their task of submitting a report on the revision of the constitution of the American Society of Civil Engineers, the committee having the matter in charge asked the directors to take a letter ballot on six points. The vote was announced informally at the meeting of the society on Apr. 19. Two propositions were carried by about an 86% vote out of the 3,200 ballots cast. These measures were the recent suggestion for organizing the society by districts and the proposal that the Board of Direction be given authority to discipline and to expel members.

There was a close vote on the admission of women to membership in the society, with the negative slightly in excess. On the question of admitting salesmen there was a decided negative majority. Whether professorial duties in an engineering school of recognized standing should be held to be equivalent to responsible charge of engineering work hereafter was decided in the negative by a 58% vote. The proposition to raise the admission requirements for membership of the highest grade was defeated by an actual majority of 24 votes.

The New York Central West-Side Lines' grade-crossing elimination in New York City, as noted in "Engineering News," Jan. 20, 1916, p. 140, has progressed to the stage where detailed plans have been filed with the Board of Estimate by Port Terminal Committee. Public hearings on the proposal will be held before final action is taken by the city. Two original sets of plans have been prepared—one for exhibition at the Grand Central Terminal offices and the other in the City Hall.

To Introduce American Goods Into Russia the American-Russian Chamber of Commerce, 60 Broadway, New York City, has decided to prepare a handbook on American financial and commercial conditions for exclusive distribution in Russia. This book will be in the Russian language and will contain a section devoted to a concise and summarized survey of industrial and commercial conditions in this country and a directory of selected American business houses prepared to furnish goods to the Russian market.

Water-Works Improvements at Lawrence, Kan., proposed for immediate execution include an iron-removal and softening plant, pumping equipment, flood protection and extensions, of the distributing system. A bond issue of $200,000 for these improvements has just been given popular approval. The city commissioners have invited engineers to submit propositions until Apr. 24 for doing the necessary engineering work. A month or so ago the city voted to buy the works of a private company. E. H. Dunmire is city engineer.

A Bill To Establish Engineering Experiment Stations has been introduced in Congress by Senator Newlands, this being the bill described by A. A. Potter "as proposed" in "Engineering News," Nov. 18, 1915, p. 995. In each state there would be

established an experiment station to study the detailed application of engineering and mechanic arts to the industries of the state—including work in water purification, sewage and wastes disposal, flood protection, road building, etc. Each state would get $15,000; the stations would be under the supervision of the Secretary of the Interior.

A $7,000,000 Trunk Highway System for New Jersey was authorized by the recent session of the Legislature, subject, however, to approval by referendum vote in November, 1916. Thirteen trunk routes, with a total mileage of about 350, are comtemplated. The $7,000,000 of bonds bears 4% interest and would be payable $500,000 yearly. This payment, with interest charges, would be met from the state motor-vehicle license fund. The routes are laid out in general terms in the bill. The exact details of the location, together with construction work, will be in charge of a highway commission of six. Four of the members would be the Governor, the President of the Senate, Speaker of the House and the State Road Commissioner acting ex officio. The other two members would be the Chairman of the Senate and House Highway Committees of the Legislature of 1916.

A Civilian Engineers Training Battalion, so called, has been formed by some 400 of the men in New York City who have been attending the lectures given under the auspices of a joint committee of the four national societies having headquarters in New York. These men have been taking military instructions at the Seventy-first Regiment armory on Thursday afternoons from 5:30 to 7 p.m. and at the Twenty-second Regiment armory on Tuesday evenings at 8.15. The object is to give such military training as may be available to engineers without interference with their regular business duties. The work will include military drill, in close and extended order; fieldwork, both tactical and engineering; rifle practice; and week-end encampments. All engineers are welcome at these drills, and they may enroll by applying at either armory. This battalion will continue to act under the auspices of the Committee on Military Engineering Lectures. The formal organization consists of an executive committee of which R. S. Buck, Engineer of Maintenance-of-Way of the New York Railways Co., is chairman; the secretary is C. R. Hulsart, Assistant Engineer of the New York City Board of Water-Supply.

PERSONALS

Mr. Harry U. Mowery has been appointed City Engineer of Wooster, Ohio.

Mr. John A. Illiman, Boone, Iowa, has been appointed County Engineer of Boone County, in charge of roads and bridges.

Mr. James L. White, formerly employed as engineer at the Ames Iron Works, has been appointed Smoke Inspector in Minneapolis, Minn.

Mr. W. W. Morehouse, Marshalltown, Iowa, has been appointed County Engineer of Polk County, with headquarters at Des Moines, Iowa.

Mr. Albert Wolstenholme, M. Am. Soc. C. E., formerly Superintendent of Streets of Fall River, Mass., has been appointed City Engineer of that city.

Mr. Edwin D. Hayward, a member of the faculty of De Pauw University, has been appointed Instructor in Civil Engineering at the University of California.

Mr. Rankin Duvall has been engaged as Road Engineer for the reconstruction of highways in Scott County, Kentucky. He is a graduate of the University of Kentucky.

Mr. Robert McCormick, who has been in the City Engineering Department of Boone, Iowa, for the past three years, has been appointed City Engineer to succeed Mr. Karl C. Kastberg.

Mr. Frank B. Manning has been appointed Superintendent of Streets of Fall River, Mass., to fill the vacancy created by the promotion of Albert Wolstenholme to the position of City Engineer.

Mr. H. O. Hickok, Rochester, N. Y., has been appointed County Engineer of Marshall County, Iowa, with headquarters at Marshalltown, Iowa. He is a graduate of the University of Michigan.

Mr. W. F. Langelier, at present connected with the Illinois State Water Survey, University of Illinois, has been appointed Assistant Professor of Sanitary Engineering of the University of California.

Mr. John C. Craig, Assistant Superintendent of the Roll Department of the Steelton, Penn., plant of the Pennsylvania Steel Co., has been made Superintendent of the Rail and Structural Mills.

Mr. J. M. Estep, M. Am. Soc. C. E., formerly Assistant Chief Engineer of the City of Cleveland, Ohio, will open an office in the Marshall Building in that city about May 1, for the practice of engineering.

Mr. James H. Roach, Assoc. M. Am. Soc. C. E., formerly Assistant Valuation Engineer of the New York Central R.R. lines west of Buffalo, at Cleveland, Ohio, has been appointed Valuation Engineer.

Mr. F. L. Wheaton, Engineer of Construction of the Delaware, Lackawanna & Western R.R., at Nicholson, Penn., has been appointed Division Engineer at Binghamton, N. Y., to succeed the late C. E. Wickham.

Mr. W. A. McTighe, formerly Assistant City Engineer of Memphis, Tenn., has become a member of the engineering firm of Baum & Haynes, Texarkana, Ark.-Tex., which will hereafter be known as Baum, Haynes & McTighe.

Mr. Floyd Angel, Assoc. M. Am. Soc. C. E., Hailey, Idaho, has been engaged as a supervising engineer on a large contract for county-road work in the vicinity of Sandusky, Ohio, in which city he will be located for at least a year.

Mr. Frank O. Dufour, Assoc. M. Am. Soc. C. E., has resigned as Senior Structural Engineer of the Central District, Division of Valuation, Interstate Commerce Commission, to go with the Stone & Webster Corporation at Boston.

Mr. F. E. Barnes, recently Chief Engineer and Manager of the Contracting Department of the R. T. Ford Co., Rochester, N. Y., has accepted a position with the New York Central R.R. Valuation Department, in charge of valuation of buildings.

Mr. John R. Wilbanks, Assoc. M. Am. Soc. C. E., has been appointed Chief Engineer of the Ferrocarril Samana y Santiago, with headquarters at Sanchez, Santo Domingo. He succeeds F. L. Weakland, M. Am. Soc. C. E., who recently resigned.

Mr. Karl Kastberg has been appointed City Engineer of Des Moines, Iowa. He was formerly City Engineer and Superintendent of Municipal Water-Works at Boone, Iowa, for 13 years and previous to that time was Assistant City Engineer of Des Moines.

Mr. John W. Budd has been elected Superintendent of the Department of Streets and Public Improvements of Des Moines, Iowa. He has been Assistant City Engineer and was Assistant Engineer on construction of one of the reinforced-concrete bridges over the Des Moines River.

Mr. Edgar B. Thomas, M. Am. Soc. C. E., formerly Assistant Engineer in charge of the River and Harbor Department of the City of Cleveland, Ohio, has opened an office at 1158 Leader-News Building as a special Consulting Engineer in river, harbor, port and municipal-improvement work.

Mr. Thomas D. Pitts, M. Am. Soc. C. E., formerly First Assistant Engineer of the Baltimore (Md.) Sewerage Commission, has been appointed Engineer in Charge of the Sewer Department under the reorganization of the various city departments by Calvin W. Hendrick, Chief Engineer of the City of Baltimore.

Mr. Amos Schaeffer, M. Am. Soc. C. E., Consulting Engineer in Charge of Sewers of the Borough of Manhattan, New York City, has been promoted to the position of Consulting Engineer of the borough. He succeeds Ernest P. Goodrich, who recently resigned. Mr. Schaeffer will receive an annual salary of $7,200.

Mr. Charles Saville, Assoc. M. Am. Soc. C. E., who was appointed Director of Sanitation of the Department of Health of Dallas, Tex., a year ago, has been made Director of Public Health of Dallas. He will have complete jurisdiction over all city matters affecting public health, including the city hospitals. Mr. Saville is a graduate of the Massachusetts Institute of Technology in sanitary engineering. He was formerly with Hering & Gregory, Consulting Engineers, New York City, and previous to his appointment as Director of Sanitation was connected with the firm of Bartlett & Ranney, Inc., Consulting Engineers, San Antonio and Dallas.

Mr. William Grant, M. Am. Soc. C. E., of the firm of Grant & Fulton, Consulting Engineers, Lincoln, Neb., has been appointed Associate Professor of Civil Engineering, in charge of water-supply and sanitary engineering, in the University of Nebraska, from which he graduated in 1897. For ten years after graduation Mr. Grant was in the employ of the Chicago, Burlington & Quincy R.R. He was City Engineer of Lincoln for three years and has since been in private practice. From 1912 to 1914 Mr. Grant made a special study at the Massachusetts Institute of Technology of the subjects to which his new appointment relates. He will continue as a member of the firm of Grant & Fulton.

OBITUARY

David H. King, Jr., former President of the New York Dock Co. and noted as one of the first builders of skyscrapers, died at his home in New York City on Apr. 20, at 67 years of age. Mr. King was President of the Park Commission of New York City under Mayor Grant and did much toward developing the city park system. He had charge of the erection of the Mills Building, which was the first big structure in New York City. He also built in New York City, Madison Square Garden, the first Equitable Building, Washington Square Arch, laid the masonry base of the Statue of Liberty and placed the statue in position on its arrival from France.

Frederick William Doane Holbrook, M. Am. Soc. C. E., who was connected for nearly 25 years with the Department of Yards and Docks at the Puget Sound navy yard, Washington, and served as Acting Head of the department a large part of that time, died at Seattle, Wash., on Apr. 13. During the Civil War he was Assistant Engineer in the defense of Washington, with the United States Army Engineers. Later he took up railway work and was at various times resident engineer at the east end of the Hoosac tunnel, division engineer with the Boston & Maine R.R., the Lake Shore & Michigan Southern Ry. and the Northern Pacific Ry., becoming Division Superintendent of the Yellowstone Division of the last-mentioned railroad in 1886. He became Manager of the Seattle, Lake Shore & Eastern R.R. in 1889, a year later was appointed Secretary of the Seattle Board of Public Works and in 1892 entered the Department of Yards and Docks. He was born at Boston, Mass., in 1840.

ENGINEERING SOCIETIES

COMING MEETINGS

AIR BRAKE ASSOCIATION.
May 2-5. Convention in Atlanta. Secy., E. M. Nellis, 53 State St., Boston.

CANADIAN RAILWAY CLUB.
May 9. Annual meeting in Montreal. Secy., James Powell, P. O. Box 7, St. Lambert, P. Q.

RAILWAY DEVELOPMENT ASSOCIATION.
May 9-11. Annual meeting in New Orleans. Secy., H. O. Hartzell, B. & O. R.R., Baltimore, Md.

NATIONAL FIRE PROTECTION ASSOCIATION.
May 9-11. Annual meeting in Chicago. Secy., Franklin H. Wentworth, 87 Milk St., Boston.

AMERICAN SUPPLY AND MACHINERY MANUFACTURERS' ASSOCIATION.
May 10-12. Convention in Pittsburgh. Secy., F. D. Mitchell, 1510 Woolworth Building, New York City.

TAYLOR SOCIETY.
May 11-13. Conference on scientific management in Cleveland. Secy., H. W. Shelton, Hanover, N. H.

INTERNATIONAL RAILWAY FUEL ASSOCIATION.
May 15-18. Annual meeting at Hotel Sherman, Chicago. Secy., J. G. Crawford, 702 East 51st St., Chicago.

NATIONAL DISTRICT HEATING ASSOCIATION.
May 16-19. Eighth convention in New York City. Secy., D. L. Gasgill, Greenville, Ohio.

SOUTHWESTERN ELECTRICAL AND GAS ASSOCIATION.
May 17-20. Annual convention in Galveston, Tex. Secy., H. S. Cooper, Slaughter Building, Dallas, Tex.

NATIONAL ELECTRIC LIGHT ASSOCIATION.
May 22-26. Convention in Chicago. Secy., T. C. Martin, 29 W. 39th St., New York City.

MASTER BOILER MAKERS' ASSOCIATION.
May 23-26. Annual meeting in Cleveland. Secy., H. D. Vought, 95 Liberty St., New York City.

AMERICAN IRON AND STEEL INSTITUTE.
May 26-27. General meeting in New York City. Secy., J. T. McCleary, 61 Broadway, New York City.

NATIONAL CONFERENCE ON CITY PLANNING.
June 5-7. Conference in Cleveland. Secy., Flavel Shurtleff, 19 Congress St., Boston, Mass.

AMERICAN WATER-WORKS ASSOCIATION.
June 5-9. Convention in New York City. Secy., J. M. Diven, 47 State St., Troy, N. Y.

AMERICAN INSTITUTE OF CHEMICAL ENGINEERS.
June 14-17. Eighth semiannual meeting. Cleveland. Secy., I. C. Olsen, Cooper Union, New York City.

SOCIETY OF RAILWAY CLUB SECRETARIES.
June 16-17. Annual meeting in Atlantic City. Secy., H. D. Vought, 95 Liberty St., New York City.

TRI-STATE WATER AND LIGHT ASSOCIATION OF THE CAROLINAS AND GEORGIA.
June 21-23. Annual convention at Isle of Pines, S. C. Secy., W. F. Stieglitz, Columbia, S. C.

AMERICAN SOCIETY OF CIVIL ENGINEERS.
June 27-30. Annual meeting in Pittsburgh. Secy., Charles Warren Hunt, 220 West 57th St., New York City.

AMERICAN SOCIETY FOR TESTING MATERIALS.
June 27-July 1. Annual meeting in Atlantic City. Secy., Edgar Marburg, University of Pennsylvania, Philadelphia, Penn.

American Railway Association will hold its spring session at the Hotel Biltmore, New York City, on May 17. Reports will be presented by the following committees: Executive, Transportation, Maintenance, Automatic Train Stops, Relations between Railroads, Safe Transportation of Explosives and Other Dangerous Articles, Electrical Working, Legal and Traffic Relations, Prevention of Accidents at Grade Crossings, and Nominations. The election of a president and first vice-president will take place at this meeting. Officials connected with companies that are members of the association are invited to be present.

Taylor Society has announced the program of the conference on scientific management at Ann Arbor, Mich., May 11-13. The papers include: "Nature and Significance of Scientific Management," by H. P. Kendall, Plimpton Press, Norwood, Mass.; "Scientific Methods of Management Applied to Various Types of Industry," by S. E. Thompson, Boston; "Scientific Management in Operation of Public Service Corporation," by Charles Day, Day & Zimmerman, Philadelphia; "An Illustrated Trip through Scientifically Managed Factories," by H. K. Hathaway, Tabor Manufacturing Co., Philadelphia. There will also be round-table discussions on scientific management for industries employing continuous and noncontinuous processes, those making uniform and nonuniform products and for construction work, merchandising, etc.

National Conference on City Planning program has been announced for the meeting at Cleveland, June 5-7. The items of greater improtance include: "The Automobile and the City Plan," by Nelson P. Lewis, Chief Engineer, Board of Estimate, New York City, and J. H. Gillespie, Police Commissioner, Detroit; "Districting by Private Effort," by Alexander Taylor, Cleveland; "Districting by Municipal Regulation," by George McAneny, New York City; "The Money Value of Good Planning in Land Subdivision," by W. G. Harmon, New York City, and O. P. von Swenigen, Cleveland; "Cleveland's Needs and Achievements," by Lawson Purdy, New York City, and Werner Hegemann, Berlin; "Planning Problems in Cities of Less Than 100,000," by John Nolen, Cambridge; "How to Get Started in City Planning," by W. T. Johnson, San Diego; "Street Systems, Including Transit Problems," by Joseph Shirley, Baltimore; "High Buildings in the Business District," by A. C. Comey, Cambridge; "Overbuilding on Land Used for Dwellings," by Thomas Adams, Ottawa.

Engineers' Society of Western Pennsylvania has arranged for a series of five lectures on Military Engineering, which will be given each Wednesday evening during May at the Carnegie Music Hall, Pittsburgh. With the object of familiarizing men of engineering training and experience with the work of the military engineer and of showing the possibilites of service in time of need, four of the talks will be on strictly military topics and one on the important allied subject of industrial mobilization. Lieut. Col. Francis R. Shunk, Corps of Engineers, U. S. A., will take the subject "The Organization and Duties of Engineer Troops"; Maj. P. S. Bond, "Military Reconnoissance, Sketching and Surveying—Military Demolitions"; Capt. C. L. Sturdevant, "Field Fortifications and Methods of Trench Warfare—Siege Operations"; Maj. J. C. Oakes, "Military Roads, Bridges, Fords and Ferries." The last lecture will be by A. L. Humphrey, vice-president of the Westinghouse Airbrake Co., on "Mobilization of Material and Industrial Resources."

New Jersey Sewage-Works Association—At the first district or local meeting of this association, held at Plainfield, N. J., on Apr. 18, there was quite a discussion on the exclusion of trash, grease and roots from sewers, as reported separately elsewhere in this issue. A collection of gas from the sludge-digestion chamber and its utilization for lighting a pumping station were reported by I. Z. Collings, Collingswood, N. J. Similar evidence of gas production in considerable quantities led to the sounding of a note of warning as to the dangers of explosions in sludge-digestion tanks, a number of which have been reported.

Several members who reported that they had received communications regarding alleged infringement of the Cameron Septic Tank Co. were referred to the National Septic Process Protective League (F. G. Pierce, Secretary, Marshalltown, Iowa). A paper dealing with various phases of sewage oxidation and suggesting a new unit to denote sewage strength, which has been named "oxygen-capacity-demand," was read by John R. Downes, Plainfield, N. J., president of the association. Before leaving Plainfield the twenty-two members who were in attendance at the meeting were taken over the Plainfield sewage-disposal works and also over the sewage-disposal plant now under construction for Plainfield and for the boroughs of North Plainfield and Dunellen.

Appliances and Materials

Coal Crusher and Sampler

An automatic coal crusher and sampler making easy the accurate production of small samples of coal shipments or purchases is being built by the Sturtevant Mill Co., Park and Clayton St., Boston, Mass. The large sample, of course, has to be gathered from the shipment as before. The crusher has a capacity for reducing, to ¼-in. size or smaller, 3,000 lb. per hr., and it diverts any portion from 5 to 15% of the total passing through.

* * *

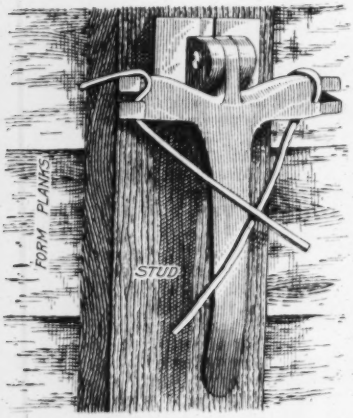
Sound-Absorbing Surface

A surfacing material that will absorb incident sound waves and that can be applied to walls and ceilings so as to become an integral part of the structure is being sold by the Tile Arch Construction Co., 7 East 42nd St., New York City, under the trade name "Amremoc." This material has been tested by Prof. F. R. Watson, of the Department of Physics, University of Illinois, and found to have an absorption coefficient of about 50%, which is 13% more than for hair felt (with which troublesome auditorium walls are padded). The material can be made to imitate any unpolished stone, both as to color and space covered. It is claimed to adhere strongly to rough tile or any similar surface; it can be applied after the walls are built and building closed.

* * *

Clamp for Form Tie Wires

The Universal wire clamp shown herewith is for tightening and holding wire ties in forms for concrete work. The tie is looped around the stud on one side and passed through holes in the form planking, the ends extending on either side of the opposite stud. The clamp is placed on this stud with the handle in vertical position above the tie, and the ends of the wire are slipped into the notched ends. The handle is then turned down, as shown, drawing the wire tight and holding it securely. For a thin wall, or where the wire is so straight as not to require tightening, the handle may be moved out 45° before placing the wires in the notches. This device is made by the Universal Form Clamp Co., 14 North May St., Chicago.



WIRE-TIE CLAMP

* * *

Reclosing Circuit-Breaker for Electric Networks

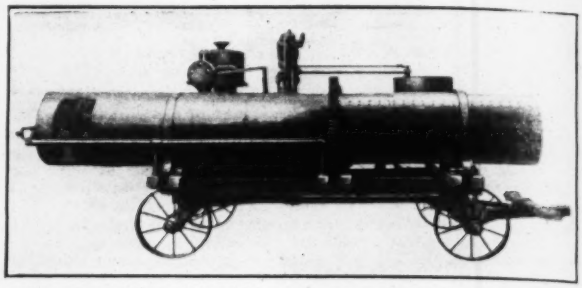
A circuit-breaker, of the automatic reclosing type but adapted for use on lines supplied from more than one source, has been developed by the Automatic Reclosing Circuit Breaker Co., of Columbus, Ohio, as an addition to its previous line. The ordinary form of automatic reclosing circuit-breaker is designed to control the entire current input to the load circuit and will not operate satisfactorily in a feeder circuit where such feeder is supplying current to a load circuit which is also supplied by current at other points.

The special feature of the new relay is a potential adjustment whereby the breaker may be set to reclose at any voltage from 50% normal to full voltage on the load side. Should the breaker open owing to an excessive load, it will reclose at the expiration of a short time interval, provided the voltage on the load side is not excessively low; should the voltage be excessively low so that the breaker would immediately open were it to reclose, the potential adjustment may be set so that the breaker will not reclose until voltage has risen to a safe value, but the instant the voltage does reach the allowable value, the breaker will automatically reclose. Should a short-circuit occur, the breaker will of course remain open until the short-circuit has been removed.

* * *

Portable Sand and Stone Drier

A light portable sand and stone drier was recently placed on the market by the Rapid Mixer Co., Grand Rapids, Mich. The arrangement of the outfit is shown in the view. The machine comprises a drum 12 ft. long and 24 in. in diameter, a 6-hp. gasoline engine, an oil tank, an oil burner and an air compressor for operating the latter. This equipment is mounted on a four-wheel truck. The drum is jacketed with asbestos at the burner end, and refuse can be kept out by a screen placed at the discharge end. The engine rotates the drum while the materials are shoveled into it and pass through under the action of gravity alone.



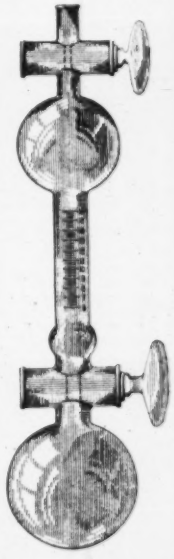
RAPID SAND AND STONE DRIER

The outfit was designed particularly for small asphalt plants, but may be used on any work requiring hot or dry aggregates. From 8 to 10 min. is required to produce material heated for use.

* * *

Pocket Flue-Gas Analyzer

A pocket CO_2 indicator for flue and furnace gases has been devised by the Bacharach Industrial Instrument Co., Pittsburgh. It is cheap, rugged, easily carried and operated. Two glass bulbs are connected by a graduated neck. Between one bulb and the neck is a three-way cock; between the other bulb and the air is a stop-cock. The device is used with the neck vertical and the open bulb at the top. After the lower bulb has been filled with KOH, the instrument is filled with gas (by a rubber tube and bulb) and the cock opened to the solution. After the CO_2 has been absorbed from the gas sample, the KOH is shut off, the instrument is immersed and the entrance cock opened, so that water flows in. The amount of water added and therefore the per cent. of gas absorbed are read directly on the neck.



POCKET FLUE-GAS TESTER

* * *

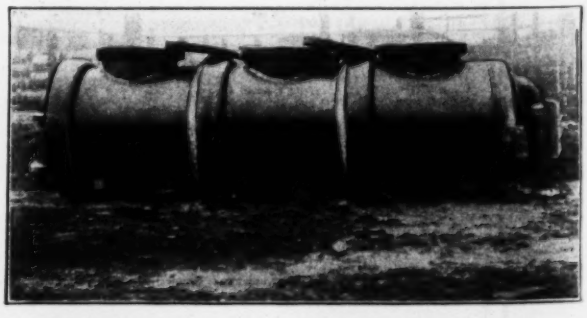
Colored Fireproof Shingles

Asbestos composition ("transite") shingles are being made by the Johns-Manville Co., of New York City, in a wide variety of colors, with rough edges and of double thickness.

* * *

Vitrified-Tile Septic Tanks

Special vitrified-clay tiles that serve as units for single-house sewage-disposal plants (like the typical one described in "Engineering News," Mar. 2, 1916) are a regular commercial product of the W. S. Dickey Clay Manufacturing Co., Kansas City, Mo., bearing the trade name "Adj-Cap." Each house tank has two or more sections, as shown in the accompanying view, according to the desired capacity. The tiles are 27½ in. in diameter and are separated by a perforated clay diaphragm. On each section is a 16-in. cleanout.



VITRIFIED TILE USED FOR SEWAGE DISPOSAL

Engineering News

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NEW YORK, MAY 4, 1916

Price, 15 Cents
Contents, First Page
Advertising Index, Last Page

Asbestos Protected Metal
Roofing *and* Siding

A P M (Asbestos Protected Metal) is permanent, involves no maintenance nor depreciation charges, is rust-proof, fire-resisting, and does not require paint.

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Asbestos Protected Metal Company
Pittsburgh

Bethlehem Steel Co., South Bethlehem, Pa
A P M Roofing

2930

Lackawanna Steel Sheet Piling Driven to 35-Foot Depth in Cofferdam Work, Pulled After Serving Its Purpose and Found to be in Prime Condition for Reuse

This evidence of Lackawanna superiority comes from the McKelvey-Hine Co., Pittsburgh, in connection with the construction of concrete piers for a new P. & L. E. Ry. warehouse in that city. The 14-in. Lackawanna Arched-Web sections shown drove their entire length in an average of less than 3 minutes each, and the completed cofferdam was excavated to within 3 feet of the bottoms of the piling sections. Upon completion of the piers, the steel sheet piling sections were pulled by an inverted McKiernan-Terry Hammer suspended from a locomotive crane as shown. The average time for starting and pulling was about $1\frac{1}{2}$ minutes for each piling section.

Observe particularly the straightness and perfect interlocks.

Recovery and reuse of Lackawanna Steel Sheet Piling in successive temporary installations is common practice, and we can cite numerous cases where this sheet piling still met difficult requirements after eight previous installations.

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For Great Britain and British Colonies in the Eastern Hemisphere, Cargo-Fleet-Iron Co., Ltd., Middlesborough, England. For France, Italy, Spain, French Colonies and Protectorates, Italian Colonies and Spanish Colonies in the Eastern Hemisphere: Cie Des Forges & Aciéries de la Marine et d'Homécourt, Paris, France.

Engineering News

VOLUME 75 MAY 4, 1916 NUMBER 18

Experience and Costs in Making Concrete-Bridge Units

By Horace M. Holmes*

SYNOPSIS—Exceptionally well laid out casting yard. Special measures required in making floor units. Reinforcing steel was bent, wired together in "cages" and set in form as one piece. Number of times forms were used. Concreting economies. Labor cost of making and handling 2,940 piles and 3,665 slabs.

The completion of the long unit-constructed concrete highway trestle across the Yolo bypass in the Sacramento Valley in California is to be celebrated on May 12. The construction of the trestle was treated in *Engineering News*, Feb. 24, 1916, p. 358. The present article tells how the concrete piles and floor slabs were made and how much they cost. The trestle—built for the California Highway Commission—is 3 mi. long and involved the making and driving of 2,940 precast piles, 14x14 in. in section and 32 to 50 ft. long, and the making, handling and setting in the bridge of 3,665 concrete floor units or slabs weighing 5 to 6 tons each. The piles contained 5,170 cu.yd. of concrete and 627 tons of reinforcing steel, and the slabs 10,530 cu.yd. of concrete and 1,118 tons of steel.

For the manufacturing of these piles and slabs a casting yard was located ½ mi. beyond one end of the bridge, the site being the nearest location to the bridge that was protected by a levee from the flood waters of the Yolo flood basin. The important features of the casting yard were the convenient track arrangement, with connections to the Southern Pacific Co., a 1,000-bbl. cement shed, a 250-cu.yd. sand and rock bunker, a 30-cu.yd. per hr. bucket elevator from a track pit to the bunker, a 1-yd. batch concrete mixer and a 20-ton locomotive crane with a 50-ft. boom. The plan of the yard is shown in Figs. 1 and 2.

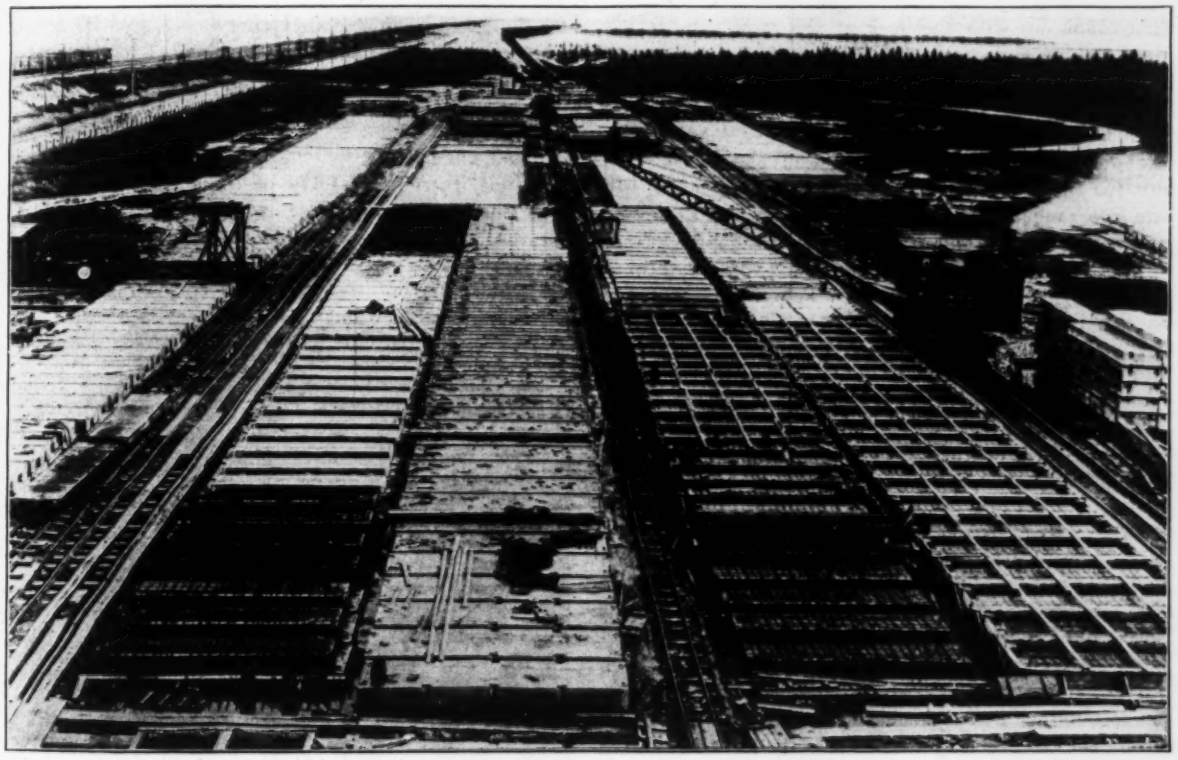


FIG. 1. VIEW OF CASTING YARD FROM SAND AND ROCK BUNKER

*Superintendent of the Graff Construction Co., Seattle, Wash.

For the casting of these 2,940 concrete piles and 3,665 floor units both steel and wooden forms were considered; but it was decided to use 2-in. wooden forms throughout on account of the low cost of lumber and the ease of obtaining it, ease of making alterations and repairs and of increasing the number of the forms needed. The daily

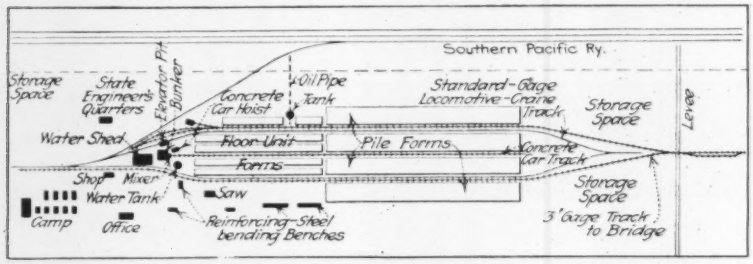


FIG. 2. LAYOUT OF YARD WHERE CONCRETE PILES AND FLOOR UNITS WERE CAST

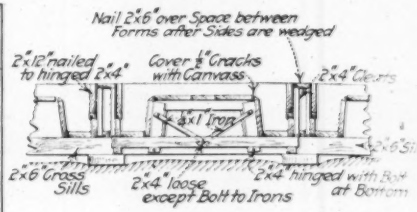

Nail 2"x6" over Space between Forms after Sides are wedged
2"x12" nailed to hinged 2"x4"
Cover ½" Cracks with Canvass
2"x4" Cleats
3"x1" Iron
2"x6" Sill
2"x6" Cross Sills
2"x4" loose except Bolt to Irons
2"x4" hinged with Bolt at Bottom

FIG. 3. CROSS-SECTION OF FLOOR-UNIT FORM

production of piles was 20, and this in conjunction with the requirement of the specifications that the piles should cure 30 days before being moved from the forms determined that 600 pile forms were necessary. A total of 177 M ft. b.m. of lumber was used for the pile forms, exclusive of the mudsills required. The bottom part of the pile forms was stationary and was used 5 times; as for the side forms, 75 pairs were kept on hand, and these were used 19 times before replacing.

To follow up with the deck at the same rate as the piledriving progressed required floor units for an average of 5 spans per day, or 25 finished floor units per day. The specifications set no length of time the floor units should cure before being removed from the forms, so 10 days was decided to be sufficient, and 250 forms were built for the floor units. The pile and floor-unit forms were so arranged that concrete could be placed in any of them from a bottom-dump concrete bucket hanging from the 50-ft. boom of the locomotive crane; and they were so spaced that when the forms were set up ready for concrete they presented an area that required no close spotting of the concrete bucket, as any excess concrete falling into one form could easily be pushed over into the adjacent form. This arrangement proved of great value in filling the forms. The bottoms of all forms rested on wooden sills, to provide for leveling up with wedges if unequal settlement occurred.

Details of Floor-Unit Forms

The floor-unit forms, on account of the recess between the beams making a space surrounded by concrete on all sides but one, presented the problem of building a form that would not bind with the swelling of the wood and would permit the picking up of the floor unit free from, and without disturbing, this bottom form. The binding due to swelling was overcome by making the sides and ends of the recess form separate from the top and hinging them so that they could be swung slightly away from the concrete as soon as it obtained its initial set (Fig. 3). The method of preparing the floor forms for concrete was as follows: The reinforcing steel for one floor unit, having been bent, made up and wired together in the steel yard, was set as one piece on the bottom of the floor-unit form. The sides of the form were set up and wedged to position and the boards placed over the space between the adjacent forms. Pieces of 2½-in. pipe were placed to form the 3-in. dowel holes, and the form was ready. The pipes for the dowel holes were removed 12 hr. after filling the forms. Also at this time the boards forming the inside surfaces of the beams were loosened. The side forms were removed after 48 hr., and the concrete slabs were picked off the forms and carried to the storage yard at the end of 10 days. The forms were well oiled every other time used and the canvas strips over cracks were painted with tallow. The boards forming the inside surface of the slab were loosened 12 hr. after concrete was poured, so that when required the slab could be picked up without disturbing the bottom form.

The 3,665 floor units were made with but one set of 250 bottom forms, which were filled with concrete 14 times each. Of side forms 85 sets were kept on hand, and these had to be replaced after being used 22 times. Lumber for forms amounted to 166 M ft. b.m. (exclusive of mudsills).

Forms for the Caps of the Bents

As but one-half of the length of the bent cap was cast at a time, there were 1,470 of these half-caps to cast. Each concrete pile when cast was provided with a 1-in. hole through the pile 22 in. below the head. This hole was to contain a bolt to support the cap-form sills. The side forms for the caps were stripped after 48 hr., the bottom forms after 8 to 10 days. The bottom forms were used 10 times, and 140 forms were required; 85 sets of

FIG. 4. COMPLETED YOLO BYPASS CONCRETE TRESTLE IN CALIFORNIA

side forms were used 17 times. There was 33 M ft. b.m. of lumber in these cap forms.

The labor cost of making, setting up and removing the forms for the piles and floor units was 2c. per square foot of concrete surface covered with forms.

The 2,000 tons of reinforcing steel was on the job before any concrete was poured. It was unloaded from the cars by the locomotive crane, special provision having been made to have it shipped with timbers under and between the bundles of bars, to make possible the attachment of the unloading chains.

For both the piles and the floor units the steel for a unit was bent, wired together and entirely prepared on benches and horses in the steel yard adjacent to the forms. These prepared units, or "cages," were transferred from the storage piles in the steel yard to the forms on two-wheeled pushcarts. As an average day's work of bending, wiring together and transferring to storage piles and to the forms, 17 men at a total wage of $52.50 per day would perform these operations on 24 of the 620-lb. floor-unit "cages," and 8 men at a total wage of $28.40 per day would perform these operations on 20 of the 463-lb. 40-ft. pile "cages." As in the case of the formwork, the daily repetition of the same operations resulted in doing exact and low-cost work. The steel for the bent caps was bent in the yard and wired together in bundles for ease of transportation, the assembling being done on the cap form.

Handling Concrete Materials and Casting Units

Sand and crushed rock for the concrete were received in bottom-dump cars and handled by the bucket elevator from a pit to the bunker. From the bunker these materials were handled by gravity into the measuring hopper of the 1-yd. batch mixer. The mixer discharged into a 1-yd. bottom-dump bucket resting on a small flat-car that was transported through the center of the yard by an endless cable operated by a reversible hoist. From the cars the buckets of concrete were handled to the forms by the locomotive crane.

A considerable part of the concreting was done at night, so as to give the crane an opportunity in the daylight to load for transportation the cured piles and floor units. As fast as the piles and floor units cured, they were lifted from the forms by the crane and transported to storage piles at one end of the yard, from which they were loaded as needed. No difficulty or breakage was experienced in the general practice of picking up the floor slabs from the forms on the eleventh day after they were cast. A double sling with spreader was used on the crane fall block, so that the stress was vertical from the lifting eyes of the floor units. The piles were lifted with a double sling hooked around the piles at about the quarter-points.

The concrete piles and floor units were hauled from the casting yard to their place in the bridge on a single track of 3-ft. gage, with passing tracks as needed, using a 5-ton and a 7-ton gasoline locomotive made by the Milwaukee Locomotive Co. A summary of this hauling is as follows:

Item	Labor Cost of Loading and Hauling	Tons Hauled	Ton-Miles of Hauling	Labor Cost per Ton-Mile
2,940 concrete piles..	$1,918	10,467	26,482	$0.073
3,665 concrete slabs..	1,770	21,317	53,932	.033
	$3,688	31,784	80,414	$0.046

To keep the track clear for serving the piledriver, the setting of the floor units was somewhat hindered and was more or less intermittent. In one run of eighteen 8-hr. shifts 897 floor units were unloaded by the traveler and set in the trestle by a gang of 11 men at a labor cost of 15c. per ton for 4,777 tons. Placing the tie-plates between the slabs and filling the joints with grout for these 897 slabs cost 13c. per ton of slabs handled.

The contract for the construction of the concrete trestle was executed by the Graff Construction Co., Seattle, Wash.

Iron- and Manganese-Removal Tests, Lawrence, Kan.

Tests of the removal of iron and manganese from water by aëration, sedimentation and filtration were made at Lawrence, Kan., in the summers of 1914 and 1915. These tests gave such encouraging results that the city feels warranted in constructing an iron-removal plant and has recently asked engineers to apply (up to Apr. 24) for the task of designing and constructing it.

The Lawrence tests were made by the State Chemical Research Division of the University of Kansas, W. A. Whitaker, Director, by James Schwab. Prof. C. C. Young, of the Water and Sewage Laboratory of the State Board of Health, assisted in directing the work. Prof. C. A. Haskins is engineer of the Water and Sewage Division of the Board. The notes here given are the substance of a summary of the tests soon to appear in Engineering Bulletin No. 7 of the University of Kansas:

The water for the City of Lawrence, Kan., is secured from wells 35 to 50 ft. deep, piercing the débris deposited by the Kansas River. This water is quite hard and contains large quantities of iron in solution, varying from 11 to 20 p.p.m., and also contains about 1 p.p.m. of manganese. A treatment consisting of a limited aëration and 48 hr. sedimentation on the continuous-flow plan, in uncovered basins, removes a large part of the iron, but there is an average remaining of 4 to 6 p.p.m.

The experimental plant consisted of an aërating tower, sedimentation basin and rapid sand filter. The aëration tower was 3 ft. in diameter by 10 ft. high and was constructed of galvanized iron. The sedimentation basin consisted of eight 50-gal. barrels connected in series. The filter was a 1x2x10-ft. galvanized-iron tank, fitted with Wheeler underdrains, a wash-water trough, loss-of-head gages and 30 in. of sand with an effective size of 0.35 mm. and a uniformity coefficient of 1.7.

Ten experiments were attempted for removal of iron by plain aëration, sedimentation and filtration, and by aëration on coke breeze, sedimentation and filtration. From these experiments the following conclusions were drawn: 1. Lawrence water can be freed from iron by aëration, sedimentation and filtration. 2. Two hours' sedimentation in well-baffled basins, after aëration and before filtration, should be allowed. 3. Rapid sand filters may be used at higher rates than are ordinarily accorded for filtering water for bacteria removal. 4. The manganese is only slightly affected by the treatment. 5. The coke trickling filter is an efficient aërator and is an excellent pre-filter, but is not necessary to precipitate the iron. 6. The manganese is not reduced by the action of the coke trickling filter, except for the slight removal affected by aëration. 7. The coke filter may be used continuously over long periods of time before the deposits become so thick that it breaks and requires flushing.

Ballasting Track by Contract

SYNOPSIS—How a new system of letting contracts for track-ballasting worked on the Missouri Pacific Ry.

Ballasting railway track by contract under a system that includes the excavating, loading, hauling, distributing and placing of the ballast is a very unusual feature in railway-maintenance work. It is even more unusual than the mere placing of the ballast by contract, which method has been employed to a limited extent. The comprehensive system first noted was employed on an extensive mileage of the Missouri Pacific Ry. during 1910-11. This is believed to be the only case where such a comprehensive system of ballasting by contract has been employed by a trunk-line railway.

There was a marked saving in cost as compared with similar work done by company forces in the ordinary way. The results were satisfactory, but the system was abandoned owing to a reorganization of the railway. There was some opposition to it at first; the operating department was inclined to regard the handling of contractors' trains as a hazard to traffic, and the maintenance department held that ballast could be put in the track better and more cheaply by the railway forces than by a contractor. The results of experience, however, were considered to show that these objections were without good foundation.

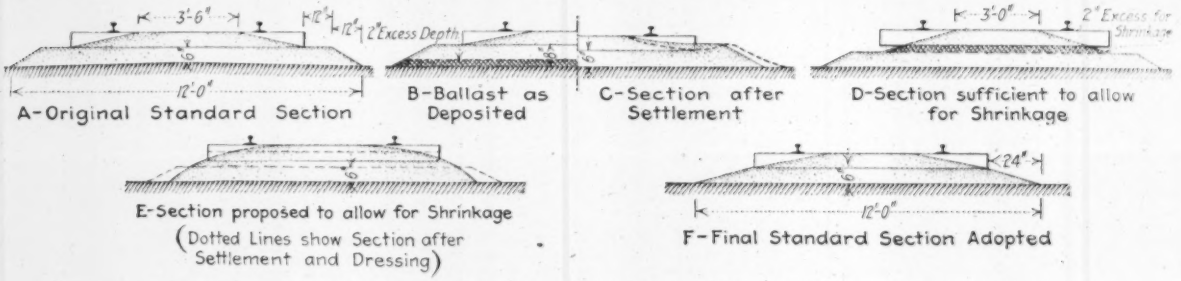
In 1908 the Missouri Pacific Ry. had about 1,800 mi. of main line ballasted only with earth and requiring proper ballast. The company's force and equipment being insufficient to carry out the work as rapidly as desired, it was suggested that the ballasting might be done by contract. M. L. Byers was at that time Chief Engineer of Maintenance of Way, and R. H. Ford was Principal Assistant Engineer.

Inquiry failed to provide information as to similar practice on other lines, so the method of putting the plan into effect had to be worked out as a new problem. Several contractors were invited to bid and were taken over the lines, but most of them considered the method impracticable and only two submitted bids. The first contracts were let to the L. J. Smith Construction Co., of Kansas City, Mo., and later the Hodges-Downey Construction Co., of Birmingham, Ala., took some of the work. The contracts were continued from year to year for three years. The former company ballasted about 1,500 mi. of track, and the latter about 500 mi.

The railway company's standard construction contract was employed, being modified to suit the special conditions. It provided (as for other work) that the company should have the right to employ at the contractor's expense such men and means as its engineer should consider necessary to complete the work within the time limit. Also that in such case it might make use of the contractor's plant. The contract specified the stretch of line to be ballasted and the location of the ballast pits. It divided the price into two items—one for loading, hauling and unloading, the other for applying the ballast (including the raising of track). A separate item covered the renewal of ties.

The contract provided that where the ballast was hauled and applied by the contractor, the quantity paid for would be that required for the minimum ballast section (on a drawing that formed part of the contract), regardless of any excess that might be unloaded. Where the ballast was hauled and unloaded by the contractor and applied by the company, the quantity paid for was to be on the basis of car measurements made at the point of unloading by the engineer.

Payment for extra work was to cover the cost of labor only, plus 10% for supervision and use of tools. Where materials and supplies were used in such work, these were to be paid for at actual cost, with no additional allowance. Payments were to be made monthly, 10% of the monthly estimate being deducted and held until the completion of the contract. To insure good work and the proper tamping of the ties, the contractor was required to maintain the track in line and surface for a sufficient period after the placing of the ballast. This period depended on the traffic, but was usually about ten days.



BALLAST CROSS-SECTIONS DURING BALLASTING BY CONTRACT ON THE MISSOURI PACIFIC RY.

Under these contracts the payment was on the basis of a certain quantity of material per mile of track. Trial was made of payment on the basis of yardage, or the quantities actually placed. This did not prove very satisfactory. It was found best for the railway company to state the desired number of yards per mile for its standard ballast section, and if any additional amount was required, to have this placed by regular authorization, the same as extra work is paid for on construction contracts.

Ballast Pits and Track Connections

The railway company provided land and right-of-way for the ballast pit, but the contractor had to furnish at his own expense all temporary rights across private property to give access to his work.

The company provided at or near the gravel-pit storage tracks (usually with capacity for 50 cars) and at the

junction with the main line sufficient tracks to handle the arriving and departing ballast trains. All other tracks were constructed and maintained (and shifted as required) by the contractor at his expense, except that the company lent him the necessary track materials free of charge. The haul from ballast pit to the work ranged from 2 to 250 mi., averaging about 90 mi. The number of ballast trains was from one to four daily.

Most of the ballast was gravel, and this was mainly loaded by steam shovels into Rodger ballast cars. It was discharged by means of a plow and cable operated from an unloader engine on a car next to the locomotive. These cars averaged 35 cu.yd. each. On some of the work chats (or zinc-ore tailings) was used. In this case the railway company loaded and hauled the ballast, delivering the trains to the contractor at a siding near his work. An inspector at the pit made the necessary measurements of loaded cars.

Locomotives and Equipment

All locomotive equipment and tools were provided by the contractor, except that the company furnished from its own equipment (and free of charge) a sufficient number of ballast cars, unloaders and plows, as determined by the engineer. The contractor was required to keep in repair all the railway equipment thus supplied and to return it in good condition (with allowance for deterioration). The company had the right to make repairs and deduct the cost from the amount paid to the contractor.

Locomotives and other equipment were required to comply with the safety-appliances law and to be subject to the approval of the railway company's superintendent of machinery. Damage to equipment in main-line movement was borne by the owner of the equipment, while the contractor was responsible for such damage outside of main line.

The company agreed to furnish bunk or boarding cars, water cars and cabooses not needed for its own use; no charge was made for them, but the contractor was required to release them on 30 days' notice if required. The contractor kept them in repair, and if they were moved over the line he saw that they were in safe and proper condition. Water was furnished free, except that where the company had to purchase it the contractor was billed for water taken at the same rate paid by the company.

Where the contractor required extra equipment or the railway called on him for extra work that necessitated the use of his equipment (exclusive of labor and force), the following daily charges were made: Locomotives, $10 with cylinders to 18-in. or $20 with 18- to 22-in. cylinders; steam shovels, $15 for 40- to 60-ton, $18 for 60-ton and over; derrick cars (including tool and blocking cars), $20; wrecking cars, $30 for 30-ton, $40 for 40- and 50-ton, $50 for 78-ton and over.

Train Service and Operation

The handling of the ballast trains was under the direction of an assistant trainmaster, whose whole time was assigned to this work. The railway company furnished at its own expense all the appliances and operators necessary for the handling of the contractor's trains on main lines, the men being under the jurisdiction of the superintendent. The company also provided the same facilities for the contractor's trains as for its own trains in similar service for movement over main, passing, side or spur tracks, giving such preference to the contractor's trains as to avoid unnecessary delay. The company further agreed to keep its passing tracks within the ballasting limits as clear of cars as practicable, in order to aid the movement of the ballast trains. The number of these trains averaged two per day.

The contractor agreed to bear all loss resulting from delays, however caused (in movements over the company's tracks, awaiting orders or moving when but partially loaded). All train movements were subject to the rules and regulations of the company. Trains outside of the ballast-pit limits (indicated by a signal near the junction with the main line) were under the direction of the superintendent or his trainmasters and dispatchers.

The contractor was required to protect the line when applying ballast, posting flagmen at proper distance in each direction. These men were furnished by the company, but were paid by the contractor and practically in his employ. The company supplied enginemen and trainmen for main-line movements. It also appointed an assistant trainmaster (approved by the contractor) to supervise such movements as noted. The pay of the enginemen and trainmen and half the salary of the assistant trainmaster was deducted from the monthly estimates of the contractor. He was made responsible for deaths, injuries or damage to property due to defective equipment, while the company was responsible for such matters in main-line movement due to negligence of enginemen or trainmen.

Contract Prices for Ballasting

The prices of the contracts varied slightly according to the length of haul and other conditions. In one contract, which serves as an example, the prices and conditions were as follows:

For loading and hauling ballast (gravel) from the ballast pit and unloading it at the point of application, 52c. per cu.yd. For applying ballast, 25c. per cu.yd. Where the ballast was hauled and applied by the contractor, the quantity paid for was that called for by the minimum ballast section, shown on the accompanying plan (1,411 cu.yd. per mi.), regardless of any excess unloaded by the contractor. Where the ballast was merely hauled and unloaded by the contractor and applied by the company, the quantity paid for was on the basis of car measurement made at the point of unloading by the engineer.

For renewing ties (including the necessary respacing), 15c. per tie renewed; ties to be furnished by the company.

On a contract where chats was delivered to the contractor in train loads (ballasting dump cars) the prices were 64c. and 79c. per yd. for hauling (from point of delivery) and unloading and 30c. for applying. The high price for hauling was due to increased length of haul.

The earlier contracts required the ballast to be trimmed to the minimum cross-section shown at *A* in the accompanying drawing. This required 1,411 cu.yd. per mi. The specifications provided that ballast should be unloaded sufficient to bring the track to the minimum section. Where an excess amount was unloaded, the contractor might either use it to fill in at the points marked by dotted lines (at *A*) or remove it for other use. In either case he was paid the contract price for loading, hauling, unloading and applying ballast called for by the

minimum section, no payment being made for excess or for labor in moving surplus ballast to other points.

The ballast was applied so as to give a 6-in. lift to the track. After being applied, or put under the ties, the track was lined to the center stakes, the contractor being paid for the extra cost where the track had to be moved more than 12 in. The ballast was then dressed to the finished cross-section. On approval by the engineer, the track was accepted by the company, which was not required to accept it in less than 5-mi. sections.

The method of applying the ballast and at once dressing it to the standard section proved unsatisfactory and led to controversy due to the shrinkage of ballast, as will be noted. In later contracts the cross-section was as shown at *F*. These contracts provided that the ballast should be distributed in quantity sufficient for a 6-in. finished lift, but should be applied in two lifts. The first, or rough, lift was to be sufficient to place not less than 4 nor more than 5 in. of ballast under the ties. The track was then left for settlement under traffic, being kept in such condition as to allow of a speed of at least 25 mi. per hr.

After sufficient time for settlement, the track was surfaced, lined and left in as good line as possible without the aid of center stakes (except where the company considered these necessary). If the track had to be thrown more than 12 in., the contractor was paid for the additional cost. Finally the track was given a finished lift of 1 to 2 in. of ballast, to bring it to grade. The ties were then thoroughly tamped, the track brought to finished line and surface, and the ballast dressed to the standard section.

Clearing the old earth ballast from between the ties in readiness for the new ballast (known as skeletoning the track) was done for such distance in advance as the engineer considered would be safe and not interfere with the use of the track. This distance ranged from one to four miles. The contractor removed all material to the level of the bottom of the ties, using this to widen or fill depressions in the roadbed.

The railway company kept close supervision of the work, its inspectors being on hand at all times to check the unloading, ballasting and all track work.

Shrinkage of Ballast

On one of the earlier contracts controversy arose over the quantity to be paid for, the contractor claiming that the final estimate did not include the full amount deposited to bring the track up to the required grade. In this case the contract specified a certain ballast cross-section and a raise of 6 in. for the track. The amount thus called for was 1,411 cu.yd. per mi., but the contractor claimed that a considerably greater quantity was required. The trouble appears to have been due to the settlement of ballast taken from the pit that served this contract, the same trouble not being experienced elsewhere.

The settlement was from 1½ to 2 in. and was so general that the engineers in the field, after setting stakes to grade, gave the contractor's foremen 2-in. blocks to place upon the stakes when distributing gravel. This means that 8 in. of ballast had to be put into the track to give the required 6-in. depth after the settlement. The additional material was applied for the full width of the roadbed, as shown at *B*, giving 310 yd. in excess, or 1,721 yd. per mi. It was really needed, however, only under the tie, as at *D*, involving 170 yd. excess, or 1,581 yd. per mi.

The settlement disturbed the normal ballast section, as shown at *C*, the ballast settling only under the ties. The engineer proposed therefore that the ballast should be filled in roughly to raise the track 6 in. plus the shrinkage, as at *E*, and then left to settle under traffic. When it had come down to the 6-in. thickness it could be trimmed to the standard cross-section, shown by the dotted line. The plan adopted, however, was to deposit the ballast in two lifts (as already described), and to finish it to the cross-section shown at *F*.

Renewing Ties and Other Work

The railway company marked such ties as were to be removed and supplied the ties and spikes for renewal. The contractor removed the marked ties, placed the new ones and respaced all ties at the rate of 18 per 30-ft. rail length. Ties were required to be placed square across the track and properly spiked. Old ties were removed to the side of the roadbed and burned or otherwise disposed of. Old spikes in good condition were utilized.

During the work suitable runoffs were made for safe passage of trains onto and off the ballasted track. The contractor was required to keep public and private crossings, streams and ditches clear of ballast or other obstruction. The company undertook to raise all bridges and culverts in advance of the ballasting; the necessary runoffs at the approaches were paid for by the contractor if within the limits of his work or by the company if beyond these limits.

Progress records were made on blueprint charts showing a series of straight lines for the railway, with stations and mileposts marked. A dotted line indicated ballast deposited, a narrow full line indicated the rough list, and a broad full line indicated the finished lift. Colors indicated the weekly progress.

A Remarkable Oil Well near Tampico, Mex., completed on Mar. 10 by the Huasteca Co., subsidiary of the Mexican Petroleum Co., 120 Broadway, New York City, is described in the "Mexpet Record" for March. This well, which is known as "Cerro Azul No. 4," has a measured daily output exceeding 260,000 bbl. of 21° Bé. oil. The well was drilled to caprock in 1915, and the well casing was cemented and tested to a pressure of 1,050 lb. per sq.in. Further drilling was suspended on account of disturbed political conditions, but was resumed shortly after the recognition of Carranza. A pocket of gas, which was struck on the night of Feb. 9, blew the water out of the well; and almost as soon as drilling began the next morning, a great body of gas was struck, blowing the drill, weighing two tons, to such a height that it landed 41 yd. away from the well. The drilling cable thrown up with the tools became so twisted about the head of the well when the tools were thrown out that the valve which had been placed on the head of the well was torn off. The crown of the derrick was carried away, and the escaping gas demolished a considerable part of the rest of the structure. About the middle of the afternoon the jet of escaping gas was followed by oil, which rose to a maximum height of 600 ft. Nearly a million barrels of oil was thrown out of the well before it could be closed. In order to save some of the oil, which was overflowing all the surrounding country, native laborers were brought in and set to work damming up a ravine. The flow from the well was so rapid, however, that the workmen could not build the dam as fast as the oil accumulated, and about half a million barrels flowed away and were burned. In closing the well, heavy tongued-and-grooved clamps were placed on the well casing, and a valve was connected to these clamps and slid over the well by means of a screw. The valve was of course open, so that the stream of oil escaped through the valve after it was in position. After it was securely bolted in place, a piece of gas pipe about 30 ft. long was attached to the valve stem, so that the workmen could stand at a safe distance away while they closed the valve.

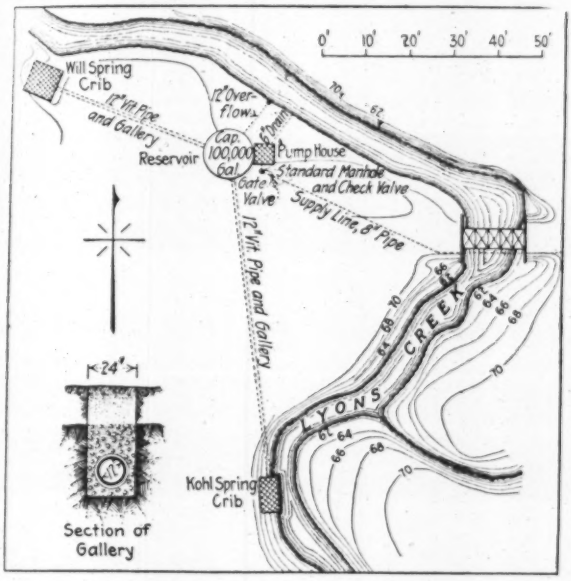
Water-Supply of 500,000 Gal. Daily from River Springs

At Herington, Kan., is an unusual water-works plant. It was completed about a year ago to replace a previous supply from driven wells, which was exceedingly hard and generally unfit for potable use.

The new supply is from springs about 3 mi. west of the city. These springs crop out on the banks and bottom of the creek in two groups about 425 ft. apart (Fig. 1). Reinforced-concrete walls were built around each group of springs and the inclosure roofed in (Fig. 2). The walls were carried well above high water and were made water-tight, to prevent contamination of the spring water with the creek water.

Water flows from the spring houses to a covered collecting reservoir of 100,000 gal. capacity (Figs. 1 and 3). The conduits from the springs to the reservoir are of 12-in. vitrified tile, a portion of which was laid with open joints to allow the infiltration of spring water encountered in digging the trench. This section was inclosed in gravel and sand filling, as shown in the detail in Fig. 1.

The reservoir is covered with a water-tight roof slab of reinforced concrete 6 in. thick, strong enough to withstand the pressure of 10 ft. of water over it, as it must frequently do when the creek is in flood. A vertical vent pipe is provided along the side of the pump house, to prevent the formation of a partial vacuum in the reservoir, when it is drawn down. The water level in the reservoir never rises to the roof, as an overflow pipe is provided about 2 ft. below the roof.



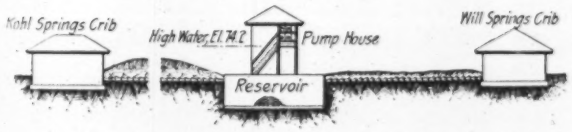


FIG. 1. PLAN AND PROFILE OF HERINGTON, KAN., WATER-SUPPLY

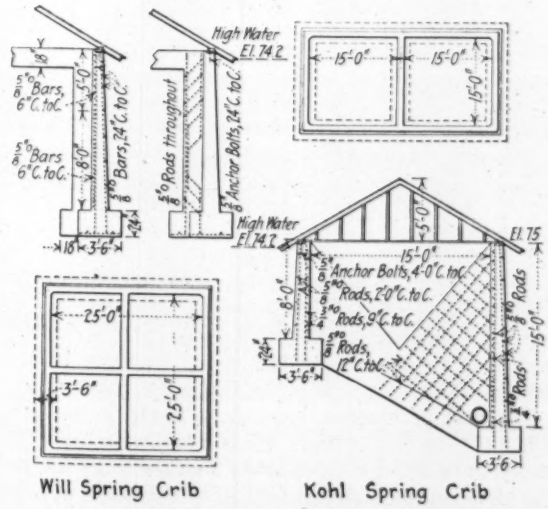


FIG. 2. DETAILS OF SPRING HOUSES

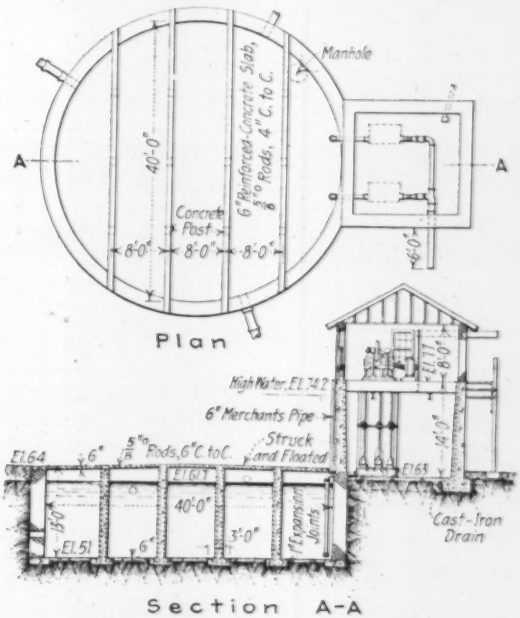


FIG. 3. RECEIVING RESERVOIR AND PUMP HOUSE, HERINGTON WATER-WORKS

The pump house is adjacent to the receiving reservoir. The lower walls of the pump house are of reinforced concrete and water-tight, to keep out the flood waters of the creek. The pumping plant consists of two triplex pumps, with extended barrels 15 ft. below the floor. One pump has a capacity of 150 and the other of 250 gal. per min. They are driven by slip-ring electric motors controlled from the municipal electric light and power plant. There is also an automatic shut-off in case the water in the receiving reservoir becomes too low.

The wells flow at a rate of between 400,000 and 700,000 gal. per day. The pumps deliver this water into an 8-in. force main under 225 lb. pressure and supply a city of about 3,500 people. The Benham Engineering Co., Oklahoma City, Okla., did the engineering work for the plant.

Freight Passing Through Canals at Sault Ste. Marie. in 1915 amounted to 71,290,304 tons valued at $882,263,141. The average haul was 832 mi. This tonnage exceeded that of 1914 by 15,920,370. The heaviest tonnage passed through the canal in 1913. It amounted to 79,718,344 tons.

Caliche Roads; A New Type of Construction in Arizona

SYNOPSIS—A cemented conglomerate, blasted from pits, is broken by sledge hammers. Resulting fragments over 4 in. in diameter are rejected. When an extra-good job is desired, the broken material is then spread on the road in layers, flooded, or "irrigated," then floated or dragged, after which the road is ready for traffic.

Except in the suburbs of Phœnix there do not exist any country-road improvements of the pavement types in the State of Arizona. The County of Yuma, in the southwest corner of the state, has just commenced the construction of a system of asphaltic concrete roads (warrenite and bitulithic) which will be practically the only road improvements of the pavement type. In other parts of the state such excellent natural road-building materials exist that there is little need for expensive pavements.

These natural materials are disintegrated granite and gravel, common to most of the mountain states, and in southwestern Texas and southern Arizona a material locally known by the Mexican name "caliche." This is a cemented conglomerate that occurs in pockets, or deposits, like gravel. It is essentially different from the gravel conglomerates frequently found in the Rocky Mountain States in the character of the aggregates composing it. The fragments of stone are sharp and angular and of all sizes. Fig. 1 gives some idea of the sharp edges of these stones. The size of the largest pieces shown is about 12 in. The stone is hard and tough and seems to be of the same nature as traprock. A pile of it looks very similar to crusher-run stone.

This material is so hard and compact that it has to be blasted (with black powder) in excavating the pits. The lumps are then broken up with sledge hammers. Fig. 2 shows a typical caliche pit on the road between Phœnix and Tempe. The cementing material appears to be rock dust and lime. Some of the caliche contains much more lime than others. That containing the most is nearly white and the cementing material has the appearance of hydrated lime.

The larger pieces of stone are thrown aside. It is intended to allow no pieces over 4 in. in diameter to get into the road surfacing. A layer of this material on a prepared subgrade packs very readily and in time forms an almost perfectly smooth-wearing surface. Even in carting the material a distance of a few miles, it becomes partly cemented together in the wagon body, so that it is necessary to break up much of it after it is dumped on the road surface.

The ordinary method of construction is to build a road like a gravel road, simply dumping and spreading the material, sometimes rolling it, but more frequently leaving the consolidating to be done by traffic. In Maricopa County, however, under H. M. Bargman, County Engineer, a different method of construction is in vogue.

The subgrade is first prepared by scraping off enough of the old material to form small dikes on each shoulder of the road (see Fig. 3). From 4 to 6 in. of caliche is then dumped and spread on the subgrade, using a light 4-mule grader or scraper (Fig. 4) to spread the material. Fig. 5 shows the character of road surface formed.

When a mile or any convenient distance has been prepared with a layer of dry material, water is turned upon the road from an irrigation ditch near its upper end, and the material is "irrigated" from 24 to 48 hr. or longer (Fig. 3). The caliche gradually disintegrates when submerged in water.

The next stage of construction is the floating of the surface, very similar to the floating of concrete, except that a large 8-mule drawn float is used instead of a hand-operated one. Fig. 6 shows the float. It is made of timber with steel-shod wearing edges. It is merely a rectangular frame with a center strut and two diagonal members. It is about 10 ft. wide and is designed to float a longitudinal half of the road at a time. This permits the road surface to be properly shaped with about a 2-in. crown. The floating both compacts the caliche and brings out the lime and dust binder.

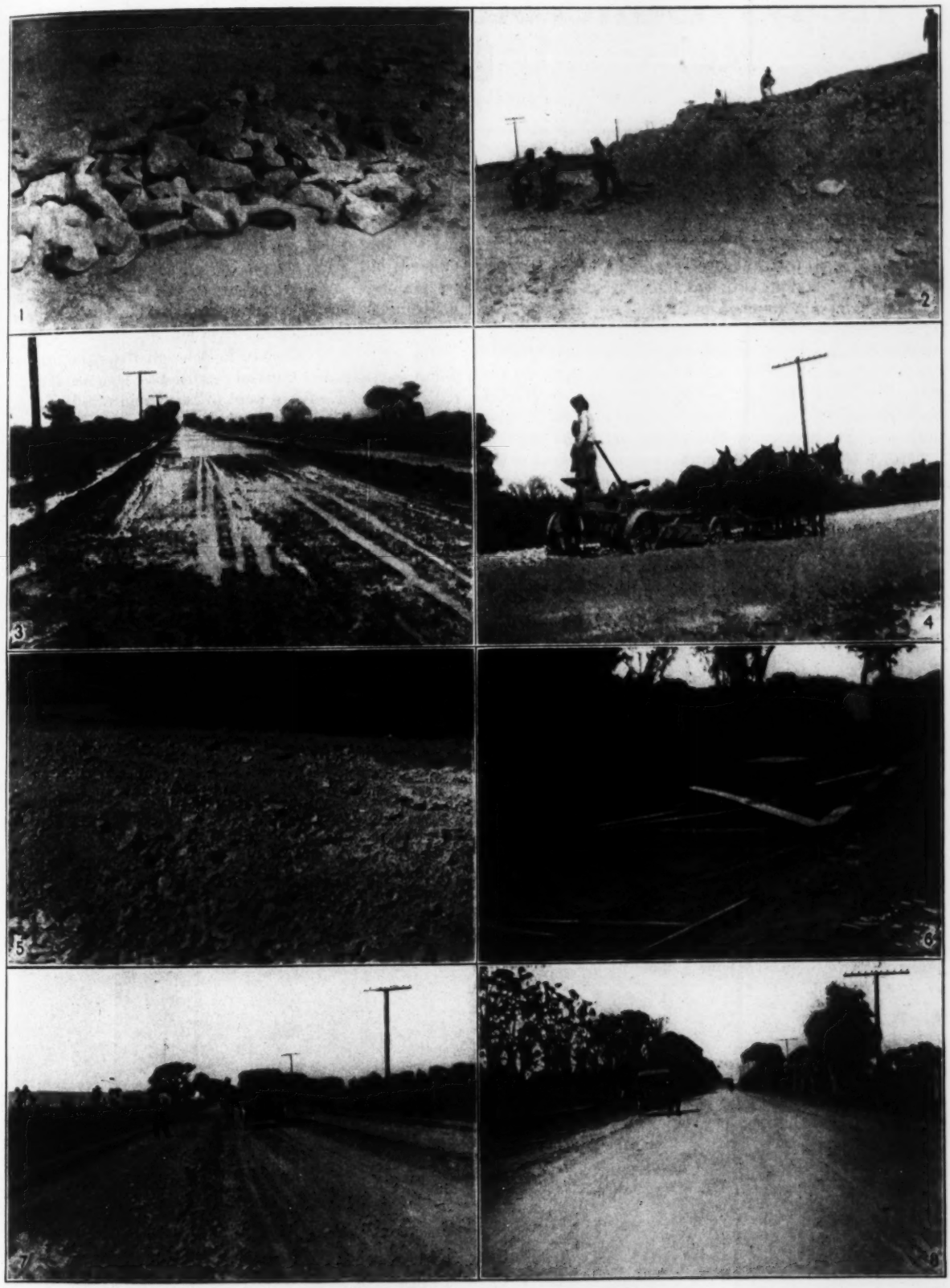
When the floating has been thoroughly done, the road is opened to traffic. The surface is not very smooth and resembles a green gravel road. This is gone over after being in use for a time and all the larger stones which have worked out to the surface are raked off (see Fig. 7) to the shoulders of the road. After this, traffic does the rest and eventually a hard smooth surface (Fig. 8) almost resembling concrete is the result.

The enemies of caliche roads, as of gravel roads, are dryness and dusting. In the long dry spells of this part of the country the caliche loses much of its binding material if subjected to fairly frequent automobile traffic, and becomes rutted. It can always be repaired in the same manner as it was originally constructed—by the addition of new material and water. Holes are cleaned out and patched in the same manner.

The possibilities of roads of this type remain to be demonstrated, but there is little question that caliche makes about as fine a natural road surface as can be obtained. If it is eventually proved that such surfaces cannot be economically maintained on the more traveled roads, the caliche forms such an ideal foundation that it is unlikely that such roads will ever require concrete foundations. Brick, asphaltic concrete or any surfacing material could be laid upon a compacted caliche base with results about the same as upon a concrete base.

A portion of the state road from Phœnix to Tempe is of caliche construction, made by spreading and compacting the material dry. State Engineer Lamar Cobb is experimenting on a stretch of this road by covering it with a carpet coat of asphaltic oil and fine gravel. Before applying the oil he has the surface carefully swept free of loose dust and sprinkled with water. So far the results have been quite satisfactory, but it is stated that a thin surface of asphaltic macadam would probably be more lasting.

The cost of constructing caliche roads is not much different from that of gravel roads, ranging probably from $2,000 to $4,000 a mile, depending on the length of haul. The state roads are all constructed by day labor, as is also the county work in Maricopa County.



CALICHE ROAD CONSTRUCTION IN MARICOPA COUNTY, ARIZONA

1—Sharp fragments of stone. 2—Typical caliche bank near Phœnix. 3—Irrigating prepared subgrade. 4—Spreading caliche for surfacing. 5—Character of surface before compacting. 6—Float used in compacting. 7—Intermediate stage of road. 8—Completed caliche road

Heavy Concrete Beams Used in Rebuilding a Theater

By Layton F. Smith*

SYNOPSIS—Interior of old brick hotel torn out to make moving-picture theater. Very long and heavy reinforced-concrete girders required in new framing.

During the past fall and early winter the old Clayton House in Wilmington, Del., was transformed from a nonfireproof hotel to a fireproof moving-picture theater. The lot on which the building stands is approximately 63 ft. wide by 210 ft. long, situated on the north side of 5th St., extending from Market St. on the west to King St. on the east. The grade of 5th St. slopes downward from Market St. to King St., which is very advantageous for theater purposes. The western, or Market St., end of the building is devoted to offices and other business purposes, as is the ground floor on King St., which corresponds to the basement on Market St. The theater portion of the building occupies the central and eastern sections, the stage extending over the shops on King St.

The Market St. end of the building remains with various changes to adapt it to the changed usages as originally built—namely, nonfireproof roof-joist construction—and is separated by a firewall from the theater proper, which has been made by tearing out the old floors and partitions and substituting a system of reinforced-concrete balconies and floors. The original plans for the remodeling of the building called for structural-steel framing not fireproofed, but after several conferences between the contractor, architect and owners it was decided to change the plans so that the structure could be built of reinforced concrete and be absolutely fireproof.

The writer was called in to redesign the structure and found several rather unusual conditions. One was that the roof beams and girders were to be of reinforced concrete to support wooden joists and roof construction. This requirement necessitated one girder 57 ft. center to center of columns, three girders 58 ft. center to center of supporting girders and one that carried the ends of the three 58-ft. girders and additional wooden trusses and had a clear span of 59 ft. All the girders were constructed as T-sections, so as not to require steel in the top for compression. They are seen from below in Fig. 1.

Another adverse condition was that the balcony, the depth of which was governed by the lines of vision of the

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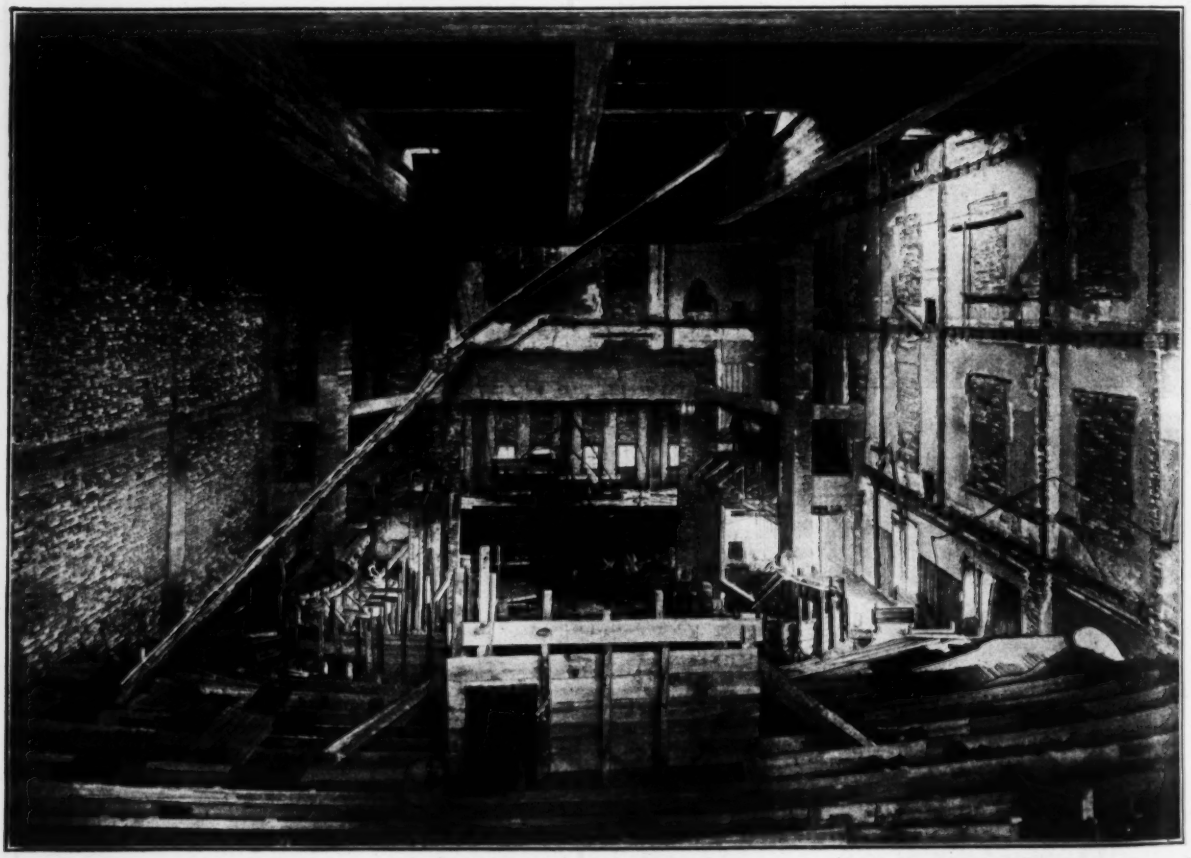


FIG. 1. INTERIOR OF AN OLD HOTEL BEING TRANSFORMED INTO A THEATER
Looking toward stage. Note long roof girders, balcony in foreground and chuting of concrete

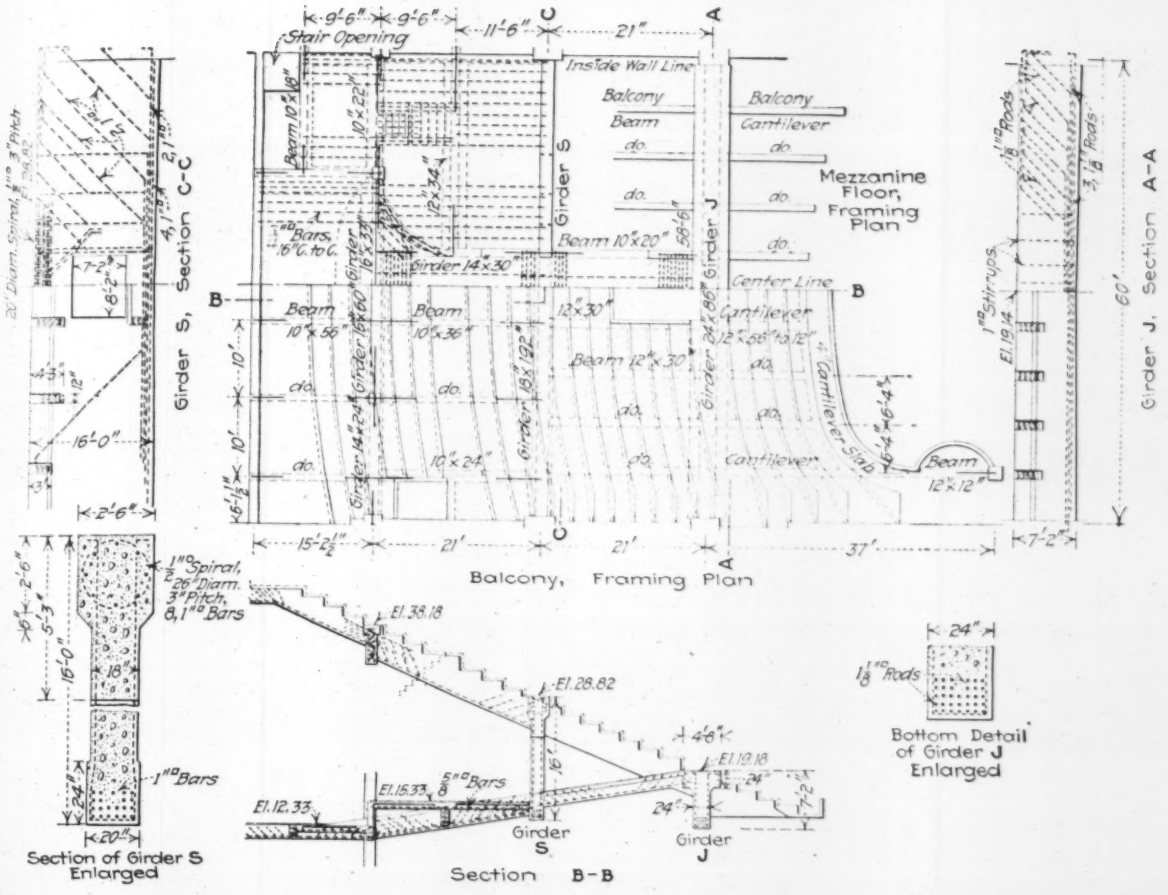


FIG. 2. GENERAL LAYOUT AND DETAILS OF REINFORCED-CONCRETE INTERIOR FRAMING

audience on the ground floor, had to be supported by girders spanning 59 ft. clear between wall columns and spaced 21 ft. center to center. The girder nearest the stage had to be about 13 ft. 6 in. back of the front of the balcony, which was cantilevered for that distance as a minimum. The maximum depth imposed by the line of vision for this fulcrum girder was 7 ft. 2 in.

Probably the most unusual condition was the transverse girder that has to support the sloping gallery on its top and carry a mezzanine floor on one side near its under side. This girder (lettered *S* in Fig. 2) is 16 ft. deep. It has an opening in its center 8 ft. wide by 7 ft. 3 in. high, through which extends a runway giving access to the balcony. On account of the sloping gallery it was impossible to construct this girder as a T-section. Consequently, the upper portion was increased slightly in width to form what might be called a bulb section, and where the opening occurred this bulb section was reinforced with a spirally wound reinforcement that extended well past the sides of the opening. This kick girder is 1 ft. 6 in. thick; and being 16 ft. deep, it forms not only a girder, but also walls for the mezzanine floor.

The method of construction of the interior framing was also unique in that the columns were carried up and the roof girders cast before the balcony was even centered. This procedure was possible because the interior brick walls of the old building were very advantageously located to support the forms and roof girders. Then the roof was covered over and the interior of the building heated, so that the balcony could be poured without danger of frost.

The concrete was chuted into place from a tall wooden tower outside the building, and the entire balcony was poured in one operation lasting about 36 hr. In Fig. 1 the chute may be seen extending through the roof to the balcony under construction. This view also shows the heavy columns supporting the roof beams.

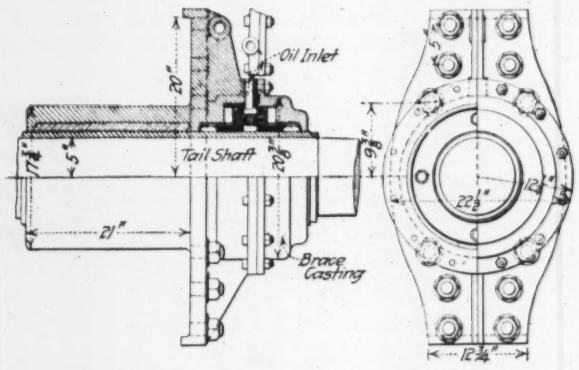
The architect for the building was the Hoffman Co., Philadelphia, Penn. J. A. Bader & Co. were the contractors, and the writer was the consulting and designing engineer.

Edmonton Contracts for Power Supply—The agreement between the Edmonton Power Co., Ltd., and the City of Edmonton, Alberta, covering a period of 21 years has been validated by the Provincial Legislature. The company undertakes to supply the city with electrical power to a minimum amount of 35,000,000 kw.-hr. annually at the rate of 1c. per kw.-hr., the price to decrease on a sliding scale until the consumption reaches 110,000,000 kw.-hr., when it becomes ½c. Negotiations were commenced about three years ago, when a company organized by G. W. Farrell, Montreal (associated with Sir John Jackson, of Sir John Jackson, Ltd., London, England), obtained water rights from the Canadian Government. On Nov. 22, 1915, the citizens of Edmonton voted in favor of the agreement, subject to its ratification by the Legislature. The construction work will be proceeded with and a dam 1,500 ft. wide built on the Saskatchewan River. Sir John Jackson, Ltd., has the contract for the dam and power house. An electric railway to the site of the dam will also be constructed.

Dipper-Dredge Bearing That Wears Slowly

Excessive wear of the outboard bearing has always been a source of trouble in the operation of self-propelled dredges. This wear is produced by the sand, mud, shells, etc., in the overflow, and the nearer an overflow opening is to the stern the greater will be the wear. It has amounted to as much as 5/8 in. in 30 days, necessitating the docking of the ship for repairs within three months of the last repair. This state of affairs and its correction are discussed in a report by W. C. Lemen and Charles G. Bochman, published in the March-April issue of *Professional Memoirs*.

Many attempts were made to improve conditions, but with small success, until a packed self-adjusting bearing was designed. It was applied to the United States dredge "Cumberland" of the Savannah (Ga.) Engineer District in January, 1914. The bearing consisted essentially of two stuffing-boxes faced so as to allow the use of three



WATER-TIGHT STERN-BEARING OF THE UNITED STATES DREDGE "CUMBERLAND"

rings each of 3/4-in. square rubber-backed flax packing, as shown in the drawing, which is pressed securely in place by two brass glands, the flanges of which are provided with leather cups similar to those in the flange packing of hydraulic jacks or presses. The glands work in opposite directions and are held against the packing by means of hydraulic pressure produced by an oil pump, when the ship is working. By trial the necessary pressure was found to be approximately 10 lb. The oil is conducted by piping to the space between the glands, the action being similar to pressure put upon two pistons moving away from each other. The tightened packing keeps out sand and grit.

The "Cumberland" underwent a general overhauling in October, 1915, after 20 months' service. The bearing was taken apart and the following conditions were observed:

The square flax packing in the outer stuffing-box had worn considerably itself and had also cut away the steel sleeve shrunk upon the tailshaft, where it came in contact with this packing, apparently due to the grit from the surrounding water entering the stuffing-box and lodging in the soft packing. This abrasion on the shaft and sleeve was most pronounced at the outer turn of packing, less so on the second turn and still less on the third or inner turn, conclusively showing that the sand would have entered the bearing except for the presence of the packing. No sand was found in the chambers between the glands nor in the packing of the inner gland.

The weight supported by this turned bearing is indicated by the fact that the "Cumberland's" shaft is 10 in. in diameter and swings a cast-iron propeller of 11-ft. diameter and 11½-ft. pitch, weighing 6,600 lb., the rotation being 107 r.p.m. After one year's successful use of the bearing on the "Cumberland" it was deemed advisable to install similar bearings upon the dredge "Savannah," a twin-screw ship whose bearings had given much trouble from rapid wear.

Reinsch-Wurl Sewage Screen, Long Beach, Calif.

By E. A. Rowe*

The sewage-disposal plant at Long Beach, Calif., recently completed in connection with a new sewer system, has two unique features: (1) It is the first plant to be put in service in this country in which a Reinsch-Wurl screen is employed, and (2) the screenings are burned at the works.

The plant is located in a reinforced-concrete building on the beach, about 400 ft. back from the ocean and approximately 10 ft. above high water. It is designed to serve an ultimate population of 50,000, based on an average daily flow of 75 gal. per capita.

The sewage first passes through a coarse bar screen (Fig. 2), from which the matter retained is raked into a trough at the top of the screen and dumped into a receiving can. After passing the bar screen the sewage flows to the Reinsch-Wurl screen, which revolves about an axis at an angle of approximately 20° from the vertical, the lower edge of the disk dipping into the sewage. This screen is made up of a number of perforated plates; and as the sewage flows against it, the liquid passes through the perforations, while the solids are deposited on the surface and are carried out of the liquid by the rotation of the screen and removed from the screen by brushes, as described later. The screened sewage passes to a sump, from which it either flows or is pumped into the ocean, depending upon the stage of the tide. The sludge is burned in an incinerator.

Description of Reinsch-Wurl Screen

The main screen consists of a circular disk about 20 ft. in diameter with plates in the shape of a frustum of a cone mounted about its axis. The entire surface is made up of plates of manganese bronze about 3/16 in. thick, perforated by slits 1/32 in. in width by 2 in. long. These

*Engineering offices of J. B. Lippincott, Los Angeles, Calif.

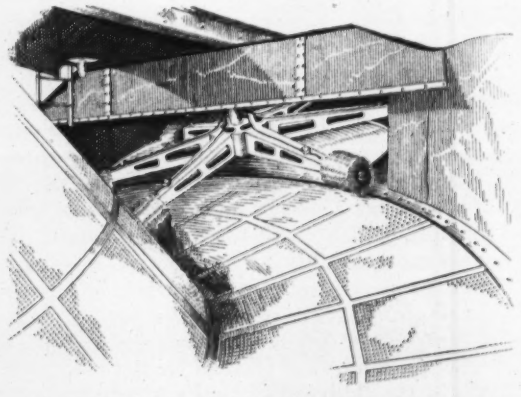


FIG. 1. REINSCH-WURL SEWAGE SCREEN, LONG BEACH, CALIF.

slits are ¼ in. c. to c. and are enlarged on the under side. The perforations are cut so that the brushes in passing over the surface tend to clean them. The screen is mounted on a steel spider hung from a large bearing at the top. In order to prevent the solids from flowing through the joint at the outer edge of the screen, steel plates carefully cut and mounted have been placed on the outer frame to seal the joint as tightly as possible. The screen is revolved by means of a rack on its under edge, driven by a pinion on the shaft carrying the brushes.

The screenings are removed by means of revolving brushes (Fig. 2) mounted on a revolving steel spider. While the spider is carrying the brushes over the screen, they are revolving in a direction opposite to the movement of the screen. The brushes are geared in such a manner as to exert no pressure upon the screen other than their own weight and to adjust themselves to any unevenness in the screen. The brushes roll the solids ahead of them, at the same time cleaning the slots in the screen. The screen plates on the conical part are cleaned by similar brushes. The screenings swept from the plates are rolled into a trough that discharges into receiving cans. The screens and brushes are driven by a 2½-hp. motor. The screen makes ½ r.p.m. and the brushes 4 r.p.m.

The receiving cans rest on a turntable that is operated by a handwheel on the main floor, so that empty cans can be placed under the trough by turning the wheel.

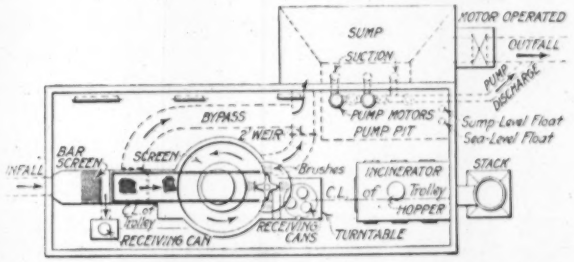


FIG. 2. PLAN OF SEWAGE WORKS, LONG BEACH, CALIF.

An overhead trolley system, equipped with a chain hoist, is provided for raising the cans to the incinerator used for burning the sludge. A record is kept of the time at which each can is filled and the net weight of the sludge collected.

Screenings Are Burned in Incinerator

The incinerator is equipped with two sets of Johnson oil burners and is designed to consume 150 cu.ft. of sludge in 8 hr., using 5 gal. of fuel oil per cubic foot of sludge consumed. The sludge is dumped into the furnace from the top about 3 hr. before the fires are started. It first rests on the upper drying hearth, located in front of the oil burners, which is built up of fire-clay brick with narrow openings between them to allow the liquids to drain to the bottom of the furnace. This liquid comes from the moisture content of the sludge, which with this system is approximately 80%. After a temperature of 2,200° F. is reached in this chamber, the top of the pile is soon reduced to an ash and from time to time is poked down on the lower hearth until the upper hearth is clean, when the fires are extinguished. The lower drying hearth is made of solid firebrick. It is parallel to the upper hearth and about 2½ ft. below it. The flames pass over the upper hearth and to the rear of the furnace, then down and over the lower hearth to the front of the furnace. The temperature on the lower hearth is approximately 1,600° F. The ash is spread over this hearth and allowed to remain here until it is removed. Below the lower hearth the bottom of the furnace is made to receive all the liquid that passes

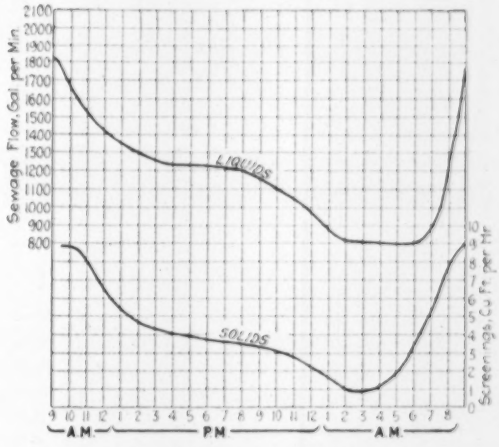


FIG. 3. SEWAGE TREATED AND SLUDGE REMOVED BY WURL SCREEN, LONG BEACH, CALIF.

down from the upper hearth and is here evaporated. The flames after passing over the lower hearth go down and over the top of the evaporating pan to the rear of the furnace and up to the stack through a series of staggered baffles placed so as to retain all the heat possible in the furnace. The temperature at the baffles is about 800° F. After the fires are extinguished, the ash is allowed to remain on the lower hearth for about 3 hr. before it is removed.

The liquid effluent after passing the screen flows through the outfall channel into the sump. A weir is located in this channel for measuring the discharge. It is equipped with a recording register, and from this record and the records of solids collected the accompanying diagram (Fig. 3) has been prepared. As the plant is not high enough to permit the screened sewage to flow into the sea by gravity at all times, a system of automatic switches has been installed, operated by floats. An automatic tide gate has been placed in the outfall so that, when the tide reaches such a level that the liquid will not flow from the sump, the gate closes and the pumps start. There are two of these pumps, automatically run so as to keep the liquid in the sump at a specified level at all times. The outfall sewer is of 36-in. cast-iron pipe, resting on a pile cradle, and extends about 800 ft. into the Pacific Ocean.

The plant was installed by the Sanitation Corporation, New York City, under the engineering direction of Olmsted & Gillelan, Los Angeles, Calif.

A Uniform Municipal-Accounting System has been worked out by the Wisconsin Tax Commission, under statutory authorization. The system has already been adopted by 18 municipalities, including Ashland, Eau Claire, Green Bay, Madison and Ripon. The Municipal Reference Bureau, University Extension Division, Madison, Wis., is prepared to lend to city officials of Wisconsin, material illustrating uniform accounting systems and showing their value. The division states that uniform municipal accounting systems have been worked out in New York, Ohio, Massachusetts, Indiana, Iowa, Washington and Wisconsin. The adoption of the uniform system is compulsory in Ohio.

Excavation for the Baldwin Reservoir, Cleveland

A large earth- and rock-moving job is under way in Cleveland in the excavation for the 130,000,000-gal. Baldwin low-service reservoir. The existing low-service reservoir, known as Fairmount, was built in 1885 and for some years has been regarded as inadequate, for 80% of the total water required for the city is now consumed in the low-service district. The capacity of the old Fairmount reservoir is 80,500,000 gal., and the daily consumption in the district is 64,000,000 gal.

In 1908 thirty acres of land extending from Baldwin Road to East Boulevard was purchased for additional reservoir purposes. In the winter of 1914-15 some work (top-soil removal) was done on the reservoir by direct labor, the sole purpose of which was to provide work for the unemployed at that time. Bids were received for the excavation on Apr. 2, 1915, under specifications which required that the contractor dispose of all the excavated material, the city allowing dumping in a near-by abandoned quarry that would hold about 300,000 yd., one-half of the total excavation.

The plans called for an excavated basin 1,035 ft. long by 576 ft. wide, with an average depth of 33 ft. The total quantity of material to be removed is 746,000 cu.yd., consisting of yellow clay, blue and black shale and bluestone. The greater part of the stone is at the east end of the basin and amounts roughly to 200,000 cu.yd.

Preliminary Investigations of Site

In recognition of the need of knowing as much as possible about the subsurface conditions at the site the city had a number of test holes sunk previous to advertising for bids and incorporated the information so obtained in the bidders' drawings (see Fig. 3). This information, unfortunately, was not altogether satisfactory, for the reason that but two of the holes went down as open pits to the depth of excavation. The holes below the open pit were made with rock drills, and the results were uneven on account of the seamy character of the rock. The heavy bluestone at the south end of the excavation was not tested by open pits, and mud brought up by the rock drills would not differ materially whether shale or bluestone was encountered. Inasmuch as the cost of excavation might be considerably influenced by the character of the material, H. P. Hammer, Assistant Engineer of Construction, Division of Water of the city, made studies of mud from the drill, in the hope of being able to determine the character of the rock from these drillings, but the results were not of a positive nature. One clause of the specifications was therefore made to read as follows:

> The contractor must assume the risk as to the nature of the ground or kind of material to be excavated, as the city does not guarantee the indications of the borings to be correct. The contractor shall not receive any extra payment and shall have no claim for damages in case the material actually encountered in the execution of the work differs from that indicated by the test borings.

Some of the contractors bidding on the work were not satisfied with the conditions as shown and made their own more or less exhaustive examinations of the site. One of them, the Fred R. Jones Co., Cleveland, made a very careful analysis of the whole situation, not only in regard to the subsurface conditions, but also in examination of the methods of spoil disposal. Whether this work, which it is stated occupied two weeks of the time of the company's engineers, was the cause or not, the Jones company was awarded the contract on the low bid of $235,505, the other nine bids ranging from $272,764 to $738,150, the average of the ten bids being $433,900.

Contractor's Plant and the Blasting

The contractor's equipment is of very high grade. The running tracks—layout of which is shown in Fig. 2—are of 75- and 80-lb. rails on hardwood ties and cinder ballast. The shovel shown at work in one of the views is a Class B 120-ton Bucyrus equipped with a 4-yd. dipper. A lighter shovel was used to remove the top soil. The spoil is moved in 30-yd. automatic all-steel Western air-dump cars. In the beginning 12-yd. wooden cars were used, but the rock damaged them considerably. Even these steel cars do not escape injury; the sideboards are

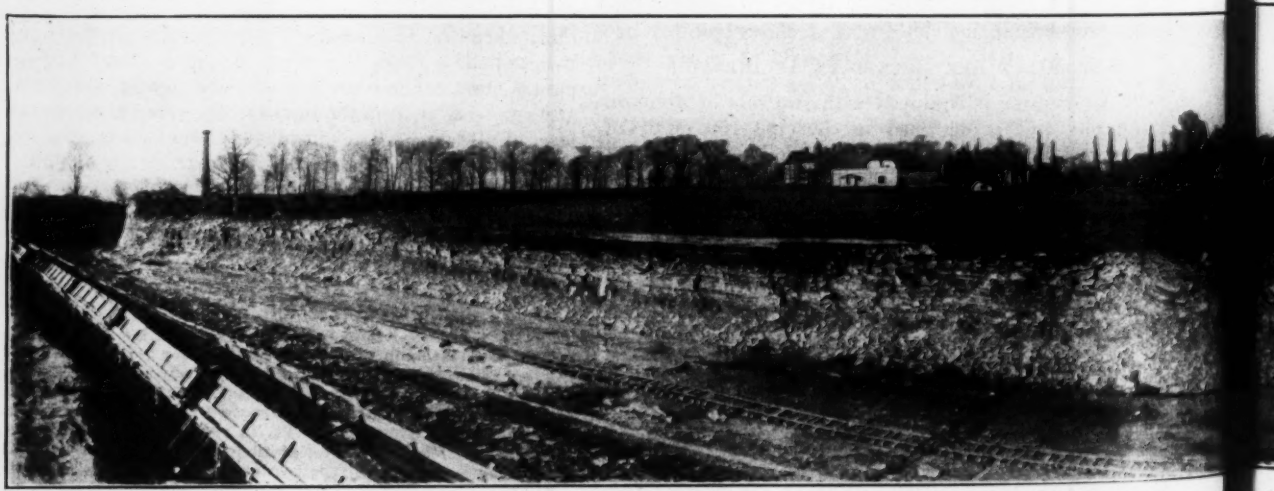


FIG. 1. ROCK-EXCAVATION WORK IN PROGRESS FOR THE 130,000,000-GAL.

Left half of panorama shows the rock strata at the southwest front of the site. The rock is hard and tests have shown it to be suitable for concrete aggregate; it will be so employed in the concrete lining of the reservoir

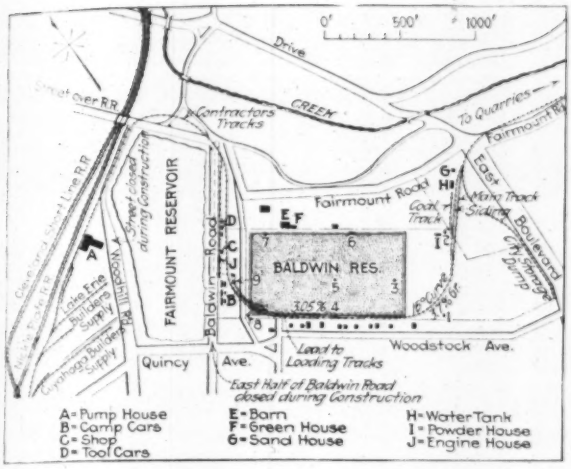


FIG. 2. CONTRACTOR'S TRACK LAYOUT AT BALDWIN RESERVOIR, CLEVELAND

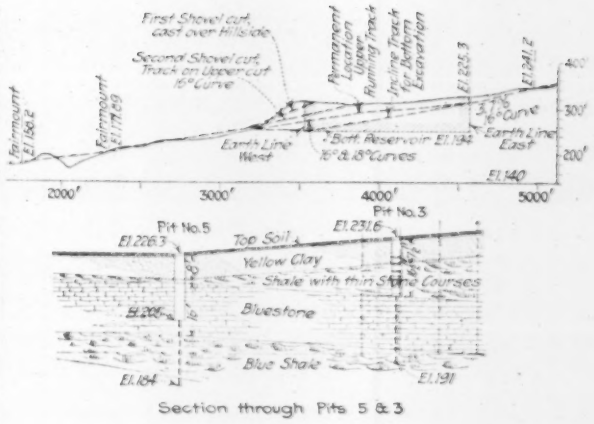


FIG. 3. CHARACTER OF SOIL AS INDICATED BY THE TEST PITS

cut by stones dropping from the dipper and by rocks (hanging out of the bottom of the dipper) being dragged over the sideboards. To get the cars out of the hole and where the grade exceeds 4.37% three locomotives are required to handle five of the 30-yd. cars—one pushing and two pulling. Pennsylvania R.R. switch engines are used. The weight of each is 50 tons on the drivers; the cylinders are 19x24 in.

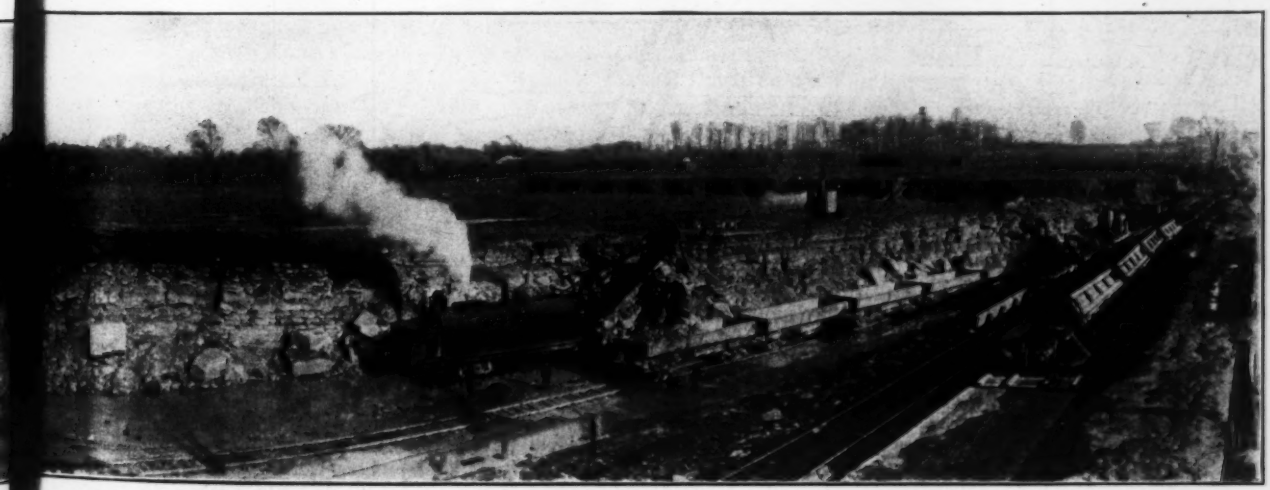
As shown by the large view, the top soil was first removed over the entire site. Rock excavation was started on the southwest side. The first cut ran the full length of the site, and the excavation proceeded northwest in parallel cuts.

The track plan shows a row of houses on the side of the reservoir where the excavation was started. Drilling and shooting were of course necessary, and great care had to be exercised in the beginning. Until the excavation reached the bottom, drainage could not be installed and the blasting holes were full of water. After the drainage system was put in, the holes were dry, and black powder could be used. The wet holes required the use of dynamite, about two cases being used in each wet hole.

Mr. Jones speaks highly of the Ingersoll-Rand turntable wagon drill, which he uses to put down the blasting holes. The machine is moved along on a track of 6-ft. 3-in. gage and drills a 3-in. hole down to 50 ft., striking 120 blows per minute. Mr. Jones says he can put down 250 ft. of hole in 10 hr. Previously to acquiring this outfit a well-drill was used.

At the present time the method of shooting is as follows: Three-inch holes are driven on about 18-ft. centers. The hole is chambered out with 16 sticks of dynamite and is then loaded with from 4 to 6 kegs of black powder. Two rows are shot ahead of the shovel, but the shovel-boom does not reach the full width of the shot. The spoil is loaded on the dump-cars, which proceed to the quarries provided by the city. The stone encountered at the south end of the cut, however, is quite suitable for concrete aggregate and is being stored by the contractor in the expectation of its being used for the concrete work to be done on the reservoir proper.

Work started May 1, 1915, to the extent of general preparation such as laying tracks. Excavation was begun on May 24. The contractor expects to finish by next July.



LOW-SERVICE BALDWIN RESERVOIR IN CLEVELAND, OHIO

This half of panorama shows the excavating and handling plant at work. Track at right is for storage of empties; loaded trains pass out on middle track; shovel loads for left-hand track, as illustrated

Engineers in Public Affairs*

By Charles R. Gow†

Much has been said in recent times concerning the desirability of engineers and engineering societies participating individually or collectively in attempts to influence or direct public affairs.

There probably never was a time in the history of our nation when there was greater need than at present for a wise and judicious oversight of the detailed actions of our governmental representatives; but the need which exists is for constructive assistance rather than for destructive criticism. There is already a great surplus of voluntary advisers who apparently seek to usurp the administrative functions of our several appointive and elective officials, leaving to those parties only the responsibility for such failures as may ensue. This I contend is an interference with good government and not an assistance. The need rather is for responsible bodies in the several communities, composed of individuals who from their nature and position command the confidence and respect of a majority of good citizens, who will analyze in a purely scientific, impartial and dispassionate manner such public acts and contemplated actions as they may by knowledge and experience be qualified to pass judgment upon and will render their decisions in accordance with the actual facts, ascertained only after an exhaustive consideration of all the evidence available, regardless of prevailing prejudice, personal effect or political consideration; who will strongly defend public officials against irresponsible criticism whenever they are found to be right, even though such officials may otherwise be lacking in popular favor; who are capable of looking on matters with a broad perspective and who are willing even to suffer personal loss if the contemplated act is for the good of the greater number of people.

I must confess that this outline of requisites presupposes an ideality not usually realized in present-day activities; but I will contend that if such attributes exist in the membership of any organization they may be expected to prevail among those composed of engineers. It is possible, therefore, that such a field of usefulness may be open to our society, but such a departure should, in my opinion, be made with extreme caution.

When we have arrived at a position which warrants assurance that a majority of our members are constituted mentally and morally so as to guarantee immunity from the danger of personal bias or attempted individual aggrandizement; when we display a disposition always to accord full credit to its proper source, even when by so doing it may be necessary to reward those whom personally we dislike; when we appear disposed to sink our own interests and welfare into obscurity and stand for a given principle at a personal sacrifice; and when we are able to brush aside all outward impressions of an indefinite and inconclusive character and form our judgment upon ascertained facts only—then may we feel justified in interfering with administrative matters of a public or semi-public nature for the benefit of the community at large.

In the meantime there is much useful work of a public character to which we may, if we wish, contribute. Our membership should be made available at all times to such public officials and commissions as may require expert opinions or scientific determination of facts.

*From the address of the retiring president of the Boston Society of Civil Engineers. The complete address is given in the April "Journal" of the society.

†Civil Engineer and Contractor, West Roxbury, Mass.

Four-Span Railway Bridge Rolled Into Place

Bridge 160 on the Fitchburg division of the Boston & Maine R.R., which has recently been replaced, spans the Deerfield River at a point 0.2 mi. west of Bardwell station. The approaches to the bridge are on a 5° 51′ curve at the east end and 4° 23′ on the west end, and these curves, with easements, extend onto the bridge 147 and 188 ft. respectively, leaving 250 ft. of tangent at the center of the bridge.

The old double-track deck bridge, 585 ft. long, composed of six spans—three of pin-connected trusses and three of plate girders—was replaced by three spans of riveted trusses and three spans of plate girders designed for a modified E-60 loading.

The principal feature of this replacement was the contractor's method of erection, which allowed the least interruption to traffic. Owing to the sharp curvature of the approaches and the lack of space on the right-of-way for assembling, it was considered more advisable to place falsework in the river and erect the new trusses along the downstream side of the old bridge. In the main the falsework was in the form of pier extensions (Figs. 3 and 4), the downstream sections to carry the trusses during erection and the upstream sections to carry the old bridge when it was rolled out and scrapped.

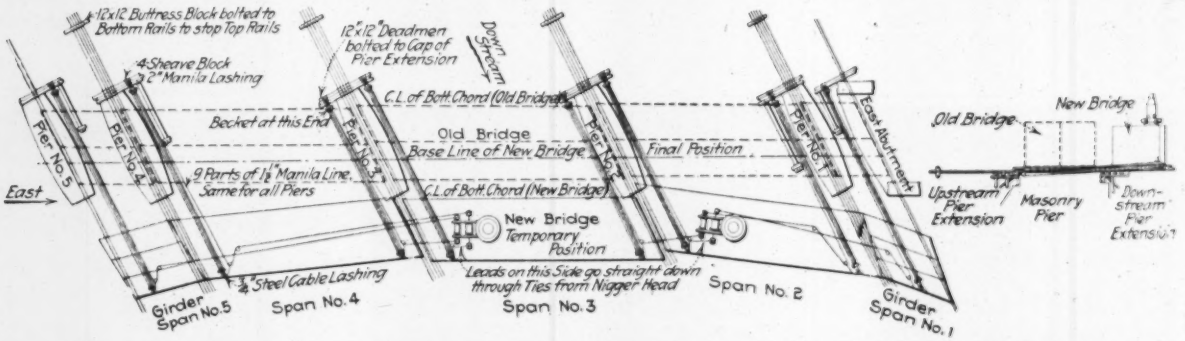

12"x12" Buttress Block bolted to Bottom Rails to stop Top Rails
4-Sheave Block
2" Manila Lashing
12"x12" Deadmen bolted to Cap of Pier Extension
Down Stream
C.L. of Bott. Chord (Old Bridge)
Becket at this End
Old Bridge
Base Line of New Bridge
Final Position
Pier No. 5
Pier No. 4
Pier No. 3
Pier No. 2
East Abutment
East
9 Parts of 1½" Manila Line. Same for all Piers
C.L. of Bott. Chord (New Bridge)
New Bridge Temporary Position
Steel Cable Lashing
Leads on this Side go straight down through Ties from Nigger Head
Girder Span No. 5
Span No. 4
Span No. 3
Span No. 2
Girder Span No. 1
Old Bridge
New Bridge
Upstream Pier Extension
Masonry Pier
Down-stream Pier Extension

FIG. 1. METHOD OF RIGGING FOR ROLLING IN NEW BRIDGE AND ROLLING OUT OLD

Three spans of the new trusses and two spans of the plate girders were erected, with bearing points on rolls and so lined that the members were exactly parallel to their final position when rolled in to replace the old bridge. After the erection was completed, the old bridge was jacked up and the same rolls extended under it.

Hoisting engines and lines were then placed as shown in the diagram in Fig. 1.

On Mar. 6, 1916, the five new spans were rolled in, the actual time consumed in rolling being 6 min. The tracks were broken for a period of 5 hr., with no delay to passenger trains. This time allowed for the throwing of the tracks on the approaches from 12-ft. to 13-ft. centers, blocking up back of parapets to allow for masonry changes, relining tracks on the westerly span and connecting the tracks on the approaches with the tracks previously placed on the bridge. The sixth, or westerly, span was placed by car derrick on Mar. 26.

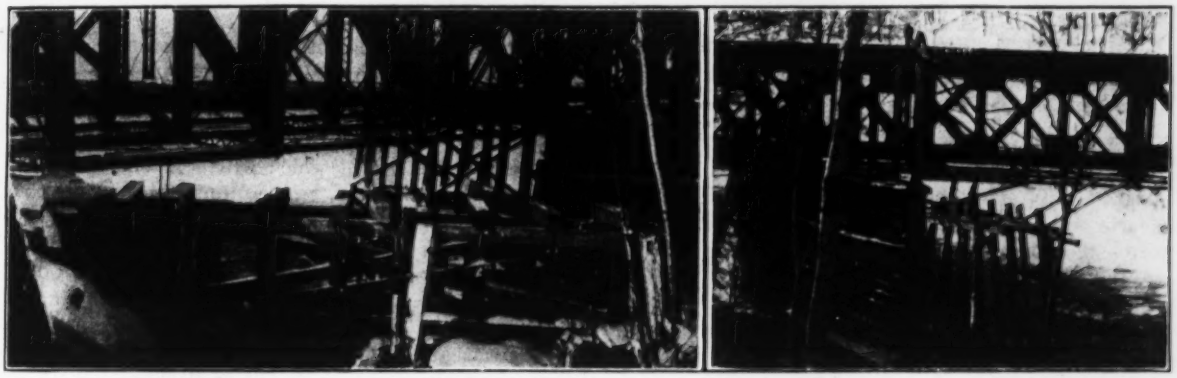
FIG. 2. BRIDGE 160 ON BOSTON & MAINE R.R. ON FEB. 14, 1916; UPSTREAM FALSEWORK AT PIERS 4 AND 5

The entire work was under the direction of A. B. Corthell, Chief Engineer. The designing was by B. W. Guppy, Engineer of Structures; and supervision of erection was by G. L. Huckins, Construction Engineer, and H. L. Farwell, Resident Engineer. The American Bridge Co., of New York City, was the contractor; H. G. Reynolds, Superintendent of Erection.

TIME SCHEDULE

Pier extensions for erection.....	Oct. 6 to Nov. 8, 1915
Steel erection, 1,200 tons.....	Nov. 10 to Dec. 11, 1915
Riveting, 42,648 rivets.....	Dec. 12 to Feb. 8, 1916
Deck work, 103,000 ft. b.m.....	Jan. 20 to Jan. 29, 1916
Average number of men per day....	40

Between Nov. 15, 1915, and Mar. 16, 1916, twenty-six working days were lost on account of bad weather. Lost efficiency of crew amounted to 40% on account of bad weather.



FIGS. 3 AND 4. LEFT—UPSTREAM EXTENSION TO PIER 1. RIGHT—UPSTREAM EXTENSION TO PIER 2

Land Drainage in Michigan

The soil in the southern peninsula of Michigan ranges from sand to heavy clay and peat and its elevation, from water level to an altitude of 400 to 600 ft. Some few large ditches have been dug by floating dredges, but the greater part of the drainage work consists of small independent ditches and tile drains. These are made mostly by hand, but also by teams and scrapers and more recently by dry-land dredges. Larger drainage matters are beginning to receive attention, and the outlook for such work is favorable.

While a portion of the land will always be occupied by lakes and streams, many of the small lakes are little more than marshes and can be entirely or mostly reclaimed. Adjacent to the lakes are marshes, peat or muck bogs, or swamps, frequently productive when reclaimed. The natural drainage of the country has been impaired by the construction of dams for power purposes and by the consequent silting of the streams and rise of the general groundwater table. This has made impossible the adequate tile drainage of a great many farms and has led to the construction of many miles of shallow drains which, while costing nearly as much as through drainage, accomplished but little good.

The Michigan law requires that a record of each drain shall be kept by the drain commissioner and that each year all the original papers of completed drains shall be filed with the county clerk. There seems to be little uniformity in the office methods, but in one county the arrangement is so good as to call for mention. The drainage office has two large rooms in the courthouse, with a large fireproof vault. The office force, besides the commissioner, consists of a deputy drain commissioner and an engineer, on a monthly salary. The latter devotes part of his time to county highway work, for which he receives extra compensation. Extra help is employed as needed for the serving and posting of notices, recording, etc. The commissioner makes constant use of his automobile, for which a nominal mileage charge is made.

The drainage record is composed of loose-leaf volumes, in order that the record may be typewritten. An alphabetical index of all drains is kept in separate books, and also an index arranged first by townships and then alphabetically, in order to facilitate the finding of a drain record whose location is known, but name forgotten.

Rapid Transit Work in 1915, New York City

By D. A. Sealey, Assistant Engineer, Public Service Commission, New York

With an introduction by Robert Ridgway, Engineer of Subway Construction, New York Public Service Commission

Introduction—A comprehensive series of articles by F. Lavis on the new rapid-transit system of New York City was published in *Engineering News* between Oct. 1 and Dec. 31, 1914. This system is generally known as the "Dual System" from the fact that it is to be operated by two companies—the Interborough Rapid Transit Co. and the New York Consolidated Railroad Co., assignee of the New York Municipal Railway Corporation—for a term of 49 years under contracts made with the city acting by the Public Service Commission for the First District, on Mar. 19, 1913. Since Mr. Lavis' articles were prepared, the construction work has advanced rapidly and at the end of 1915 was a little over 50% completed.

A paper read before the Municipal Engineers of the City of New York by LeRoy T. Harkness, Assistant Counsel, Public Service Commission, entitled "The Dual System Contracts in Their Relation to the Rapid-Transit History of New York City," published in the 1913 "Proceedings" of that society, gives a very clear and interesting description of the features of the Dual Contracts under which the new system is being constructed and will be operated. The article by Mr. Sealey which follows describes briefly some of the features of construction and states what progress has been made.

The question is frequently asked why the contracts for construction were so arranged that several miles of trunk subways in Manhattan, along Broadway and Lexington Ave., and in the Bronx were completed a year in advance of the time when the remaining sections can be completed and put in operation. The answer is that these sections were intended to form part of the so-called "Triborough" route originally designed for an independent system of operation, and the contracts for their construction were let in 1911 and 1912, whereas the Dual Contracts date from 1913. In the latter contracts provision is made for incorporating in the respective operating systems the Triborough sections then under construction, as well as the completed Center St. loop in Manhattan and the then nearly completed Fourth Ave. subway in Brooklyn.

Mr. Lavis compared the cost of it with that of the Panama Canal, which was $375,000,000. As of interest in this connection the table on this page shows by years from 1907 to 1915 inclusive the gross amounts estimated on account of the construction of the city-owned lines, including both the city's and each company's share. In addition, a large amount has been spent by both companies in third-tracking and extending the company-owned elevated lines.—Robert Ridgway.

Rapid-transit construction in New York City has progressed steadily since the signing of the Dual System contracts Mar. 19, 1913. The Dual System project involves the construction of new elevated and subway lines and the reconstruction and extension of existing elevated and subway lines. In general, the Interborough company will operate all the lines in the Borough of the Bronx and lines throughout the length of Manhattan, with elevated lines extending into the Borough of Queens and certain elevated and subway lines extending into the Borough of Brooklyn, while the Municipal company will operate most of the elevated and subway lines in the Borough of Brooklyn, with sufficient subway lines entering Manhattan to distribute passengers.

The two maps, Figs. 1 and 2 (reproduced from *Engineering News* of Oct. 1, 1914), define the new lines and show the complete rapid-transit network. On completion the system will have treble the capacity of the existing lines. The estimated total cost of the new system, including construction and equipment, approximates $350,000,000, of which the Interborough will contribute about $105,000,000, the Municipal company about $61,000,000 and the city about $184,000,000. The city has already invested about $56,000,000 in the construction of the present subway and the Interborough Rapid Transit Co. about $48,000,000 in equipment on this line, representing about $104,000,000 which is not included in the above estimated cost; the cost of the existing elevated railways is also not included.

The new system, including existing and proposed elevated and subway lines, will comprise about 620 mi. of single track, 360 mi. of which will be operated by the Interborough and 260 mi. by the Municipal company.

At the close of the year 1915, out of the total of 89 contract sections of the city-owned lines the Public Service Commission had awarded 73 contracts of value $167,606,989.70. It is expected that the remaining 16 contracts will be awarded during the present year. The 26 contracts awarded in 1915, together with other contracts for station-finish work and track, aggregate $26,096,639. In addition, the value of work either completed or under construction on third-tracking and extensions of elevated railroads by the companies at the close of the year 1915 amounted to $25,000,000.

TABLE OF EXPENDITURES ON CITY-OWNED LINES OF NEW RAPID-TRANSIT SYSTEM, NEW YORK CITY

(Amounts given include both city and company share of cost. Third-tracking and extensions of company-owned lines are not included.)

	I. R. T. Co., Contract 3	N. Y. M. Ry. Corp., Contract 4	Total
To Dec. 31, 1907*	.....	$975,364	$975,364
To Dec. 31, 1908*	.....	4,602,877	4,602,877
To Dec. 31, 1909*	.....	7,327,769	7,327,769
To Dec. 31, 1910*	.....	12,500,707	12,500,707
To Dec. 31, 1911*	$275,340	20,219,446	20,494,786
To Dec. 31, 1912*	6,041,544	25,539,169	31,580,713
To Dec. 31, 1913*	16,293,199	31,468,958	47,762,157
To Dec. 31, 1914	33,219,215	42,590,207	75,809,422
To Dec. 31, 1915	54,635,206	54,925,299	109,560,505
City's share	$35,752,557	$50,576,458	$86,329,015
Companys' share	18,882,649	4,348,841	23,231,490
Total to Dec. 31, 1915	$54,635,206	$54,925,299	$109,560,505

*The figures for the years prior to 1913 and part of the 1913 expenditure represent construction of the Center St. loop in Manhattan, the Fourth Ave. subway in Brooklyn and the Broadway-Lexington Ave., or Triborough, subway in Manhattan and the Bronx—two Bronx sections besides the Harlem River tunnel and the Lexington Ave. section being under contract. These construction expenditures were taken over into the Dual Contracts arrangements.

The total value of construction completed as of Dec. 31, 1915, was $109,560,505.

The average daily force of the contractors on all of the work under the Dual System, including company and city contracts, is at present about 15,000 men. This force has been larger in the past, reaching a maximum of over 20,000 men. There are at present about 1,500 engineers of all grades on the commission's payroll, and the cost of engineering for the past year amounted to $3,000,000.

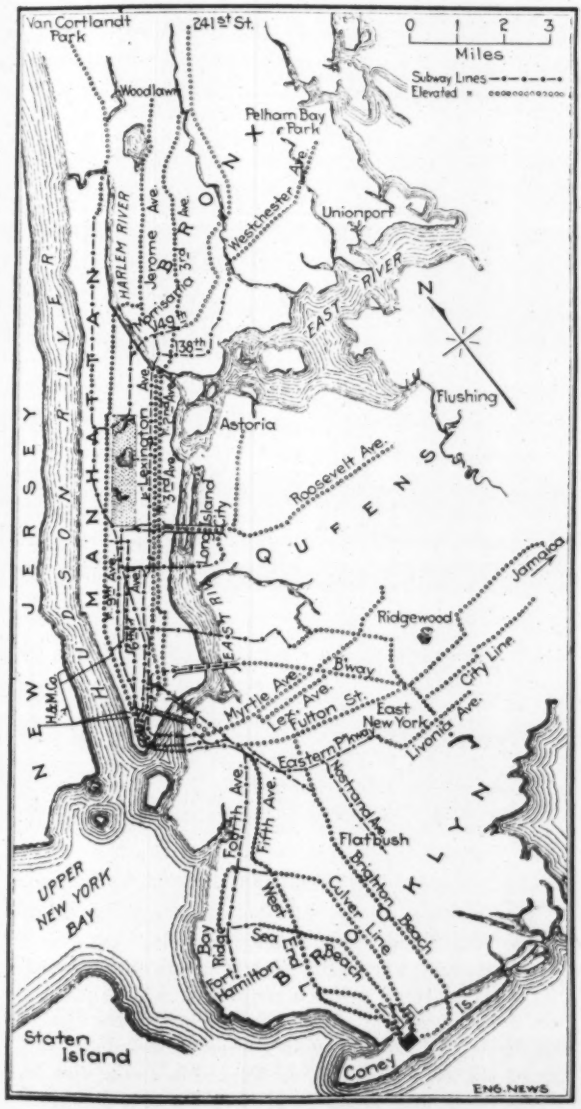
The scope of this article will not permit a description in detail of construction progress since the signing of the Dual System contracts. The statements below will therefore be confined to the past year.

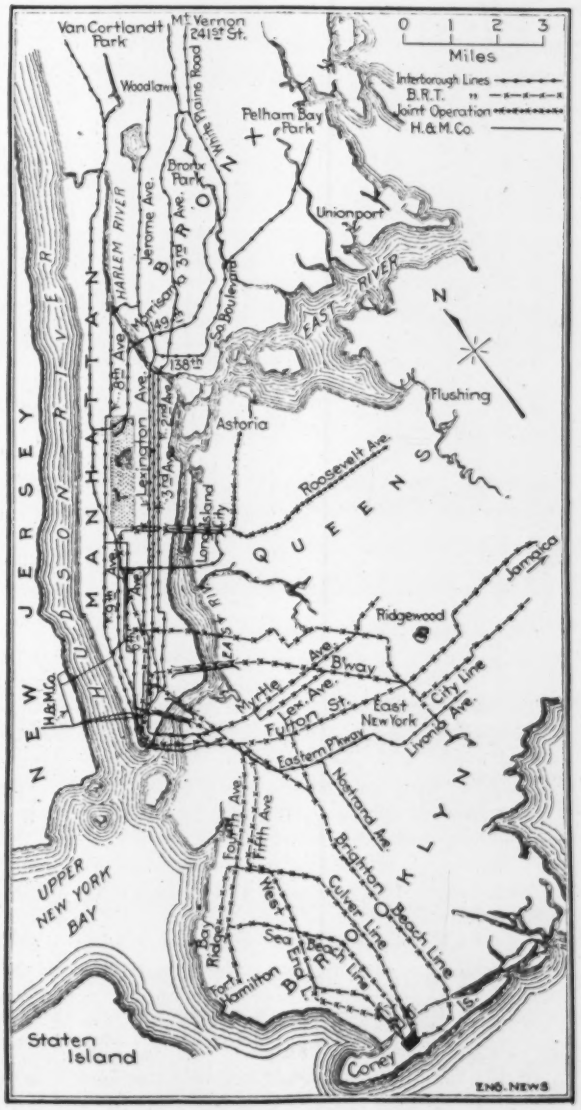
Interborough Lines—Lexington Ave. Line

The existing subway in Manhattan is extended north from 38th St. and Park Ave. as a four-track subway, curving under private property where the Grand Union Hotel formerly stood, thence under 42nd St. to Lexington Ave., by way of Lexington Ave. and the new Harlem River tunnel into Bronx Borough and by way of Mott Ave. and Girard Ave. as far as 157th St., whence the line continues north as a three-track elevated structure for a distance of about 5 mi. along Jerome Ave. as far as Woodlawn Road near the city line. At 135th St. a line branches to the east as a three-track subway under 138th St. and to Pelham Bay Park, a distance of about 6¾ mi.

The entire Lexington Ave. line north of 53rd St. is now nearing completion, including the westerly branch into the Bronx and the easterly branch as far as Whitlock and Westchester Ave. Work on the elevated structure along Westchester Ave. from Whitlock Ave. to Pelham Bay Park will shortly begin. This work comprises a new section, bids on which were opened Nov. 30, 1915 (the contract has since been awarded).

Work on the section from 43rd St. to 53rd St. was begun in August, 1914, and is now over 45% completed. North of 46th St. this section is a double-deck structure with the two express tracks below and the two local tracks above, an arrangement typical of the greater part of the Lexington Ave. line. South of 46th St. the local tracks diverge so as to permit the express tracks to come up be-





FIGS. 1 AND 2. THE ULTIMATE RAPID-TRANSIT SYSTEM OF NEW YORK, AS IT WILL BE IN 1918

tween them, all tracks reaching the same grade at about 44th St., approaching the station south of this point.

The contract section for the connection with the present subway extends from 38th St. north along Park Ave. to 41st St., thence curving northeasterly under the site of the old Grand Union Hotel and 42nd St. to Lexington Ave., the hotel having been razed in connection with subway construction.

The Diagonal Station

A station extends diagonally across the old Grand Union site and 42nd St. and consists of two island platforms with the express tracks between and the local tracks outside of them. On account of its diagonal position with respect to the rectangular streets, it has been popularly called Diagonal station. The construction of this section is of unusual interest, particularly the work south of Diagonal station, on account of its proximity to the present subway as well as the street-car tunnel located directly above the subway tunnels in Park Ave. The latter consist, south of 41st St., of two separate two-track tunnels, built sufficiently far apart to permit the construction of a tunnel between them for the two new express tracks from Diagonal station. This tunnel passes under the northbound tunnel of the present subway, rising to a connection with the present express tracks at about 39th St. The southbound local track after leaving Diagonal station is carried in a separate tunnel under the existing subway tunnels, continuing south under the west sidewalk of Park Ave. on a rising grade to a connection with the southbound local track of the present subway near 38th St. The northbound local track enters Diagonal station from a connection between 40th and 41st St. with the existing northbound tunnel.

Within the limits of private property the work is being carried on in open cut, while under 42nd St. and north the work is being done under decked roadways. Excavation for the tunnels from Diagonal station was started from the site of the hotel (Fig. 5). A shaft was also sunk within the park space on Park Ave. south of 40th St. to the subgrade of the new express tunnel and excavation carried north and south from this shaft. The excavation is in rock in the tunnel portions and in earth and rock in the open-cut portions. The material is hauled to the Grand Union site by mules, raised by electric derricks to the street level and removed by horse trucks. The excavated material is disposed of similarly through the 40th St. shaft. The contract time for completion of this work is 28 months, and the contract bid price (including a portion of the Steinway tunnel extension) is $3,097,312.50. Work was started in December, 1914, and is now over 47% completed.

Considerable care in the prosecution of this work is required so as not to interfere with traffic in the present subway. A slight conception of the problem can be had when it is considered that express trains pass this point every 1½ min. during rush hours and local trains every 2½ min. It should also be remembered that over 1,000,000 passengers are carried in the subway daily. No express trains run between 1:30 and 5:30 a.m., and such work as setting protecting shields and permanent steel columns within the present tunnels is done during these hours.

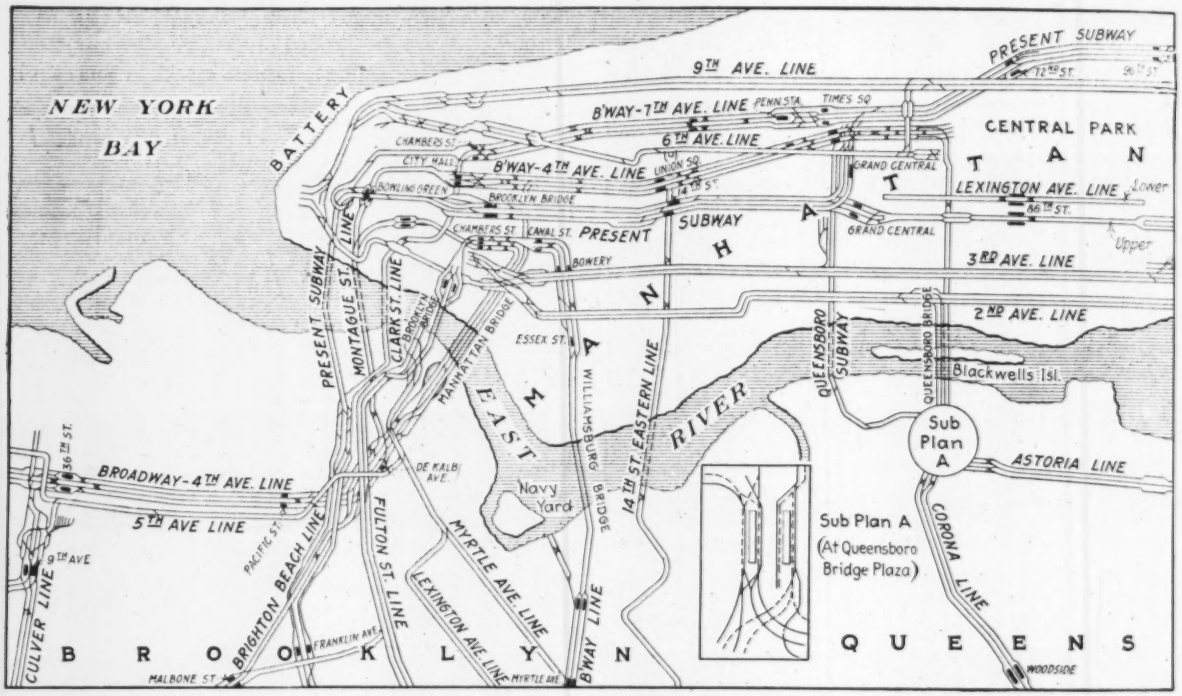


FIG. 3. TRACK SYSTEM IN HUB OF NEW YORK RAPID-TRANSIT SYSTEM

Seventh Ave. Line

The existing subway on Broadway will be extended south from Times Square under Seventh Ave., Seventh Ave. extension, Varick St., West Broadway and Greenwich St. to the Battery, where a connection will be made with the present subway loop. Its eight contract sections aggregate $14,793,449.50 in construction value. It is a four-track subway north of Park Place, the two outer tracks continuing south from Park Place to a connection with the present South Ferry loop. Actual construction

were started on these different sections at various dates in 1914, and exclusive of the connection at Times Square (which was finished within the past year) the work is from 51% to 84% completed.

The construction of the Times Square connection involved the entire removal of the west wall of the present subway between 43rd and 44th St. and the reconstruction of a large portion of the roof of the present subway within these limits. Like the Diagonal station work, it had to be prosecuted without interruption to traffic in the present subway.

The Seventh Ave. line is being built in trench under timber street decking, excepting within the limits of Battery Park and in Varick St. Extension and Seventh Ave. Extension—new streets not yet graded—and in the widened portions of Varick St. Rock has been encountered on all the sections north of 16th St. and in Battery Park; otherwise the material excavated consists in general of sand, gravel and clay, with occasional boulders. Filled ground was encountered in places, particularly south of Vesey St. along Greenwich St., which marks approximately the old shore line of the Hudson River during the days of the Revolution. For some distance north and south of Franklin St. a peat bed several feet thick was found, in which a number of well-preserved cedar logs and stumps were embedded; the peat was covered with 15 ft. or so of filled ground. The disposal of excavated material is being handled by the usual method of shafts and hoisting plants located at intervals along the line of the work.

Considerable underpinning of buildings has been required, particularly on the lower sections through Greenwich St., where many of the buildings are old and have shallow foundations. A special feature of this work was the underpinning of two lines of columns supporting the existing elevated-railroad structures along Greenwich St. and West Broadway.

Park Place and Beekman St. Branch

The two middle tracks of the Seventh Ave. line turn east at the northeast corner of Park Place and West Broadway, thence pass under Park Place, cross under the new double-deck Broadway subway, the general post office and the existing subway in Park Row, go by way of Beekman St., William St. and Old Slip to a pair of tunnels under the East River to Brooklyn and by way of Clark St. and Fulton St. to a connection with the existing subway at Borough Hall.

Because of the necessity of passing under the Broadway and Park Row subways the grades in Park Place and Beekman St. are as steep as 3%, and the structure is deep—about 60 ft. below the street surface under Broadway. An island-platform station at Church St. will, on account of the depth, be provided with escalators.

In Park Place and in the easterly portion of Beekman St. the work is being carried on in trench under timber street decking; the rest of the section, exclusive of the work under the post office, is being built in tunnel. The excavated material generally is sand, and subgrade is below groundwater level.

The portion of the two-track subway under the post office is built in a cut opened through the floor of the sub-basement of the building and passes below three rows of cast-iron columns of the building, the center line of the subway being directly below the middle row of columns. The cast-iron bases of these columns are in the sub-basement floor and rest on 12-in. granite caps 4½x 4½ ft. square, supported on continuous concrete footings about 10 ft. wide and 4½ ft. deep. The concrete floor is cut away between the lines of columns, and 15-in. transverse latticed girders incased in concrete are placed between the lines of columns under the granite caps, one girder on each side of each column. Directly under the 15-in. girders are placed 30-in. continuous longitudinal latticed girders, one on each side of the granite bases of each row of columns. In the order of underpinning operations the 30-in. girders are placed first. The placing of these longitudinal girders involves cutting away a portion of the existing concrete footings on each side of the lines of columns, in order to place the girders near enough to the columns. The concrete is then replaced, inclosing the girders and making them integral portions of the footings. For the purpose of bonding the concreted girders to the

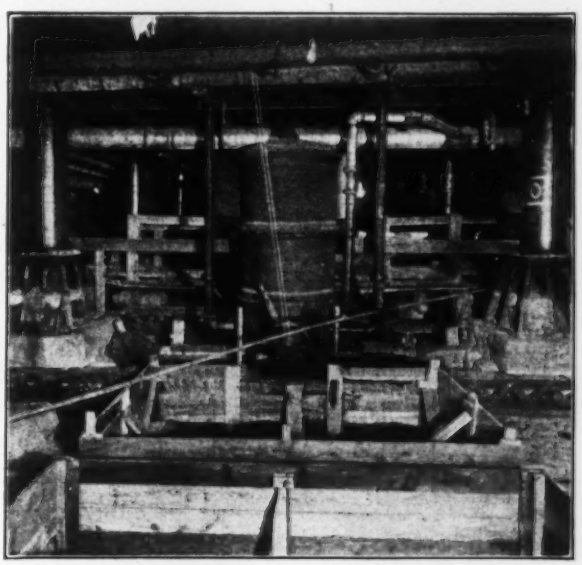


FIG. 4. SUBWAY WORK IN SUB-BASEMENT OF DOWNTOWN POST OFFICE

footings, dowel pins 1¼ in. square and 36 in. long are driven into holes drilled horizontally 18 in. into the concrete footings.

The footings are carried down by means of underpinning pits 5 ft. square to the proper depth, usually to groundwater level, below which 14-in. concrete piles are put down. Above subgrade these piles will be incorporated in the walls of the completed subway structure. The subgrade of the subway is 30 ft. or more below the sub-basement floor of the building. The estimated loads coming upon these building columns vary approximately between 350 tons and 800 tons per column. Fig. 4 shows the work in the sub-basement of the post office.

Work between West Broadway and William St. was started in December, 1914, and is now over 39% completed. The contract bid price was $1,571,363.50.

A special feature of the work under William St. is underpinning of buildings. On account of the narrowness of this street, which is about 40 ft. wide between building lines, every building along the line has to be underpinned. These buildings vary in height up to 20 stories. The method of underpinning was described quite fully in *Engineering News* of Apr. 13, 1916, p. 681.

Work in William St. started in December, 1914, and is now about 59% completed. The contract bid price is $2,254,670.

East River Tunnels

The Old Slip-Clark St. tunnel is 5,900 ft. long and is made up of two single-track cast-iron-lined tubes, 17½ ft. in external diameter. Work on this section started in August, 1914, and is now about 35% completed. On the Manhattan side, shafts are located in the north and south roadways of Old Slip at Front St. On the Brooklyn side a double shaft is located at the foot of Clark St., partly in Furman St. (Fig. 9). These shafts have been sunk as caissons under compressed air, with walls of steel and concrete, and will be used in the permanent structures as emergency exits and ventilation shafts.

Four headings are being driven from the Manhattan shafts, two toward the river by use of shields and two landward by a crown-bar system of poling and breasting. The river headings are in rock in the lower portion of the tunnels, while their upper portion is in river mud and filled ground containing old foundations, piles and cribbing. On the Brooklyn side where the excavation is in sand, four headings—two landward and two toward the river—are being driven by the use of shields.

Just south of the Old Slip-Clark St. tunn another pair of tunnels under construction from hall St. (Manhattan) to Montague St. (Brooklyn), ing a portion of the New York Municipal Railwa tem. Both pairs of tunnels are being built by the contractor.

Brooklyn and Queens Lines

A four-track extension of the present subway from its terminus at Flatbush and Atlantic Ave., Brooklyn, passes along Flatbush Ave. and Eastern Parkway to Buffalo Ave., with a two-track branch subway along Nostrand Ave. from Eastern Parkway to Flatbush Ave. The portion of the subway under Flatbush Ave. from Pacific St. to the Prospect Park Plaza will be a six-track structure, two tracks of which will be used by the New York Municipal Railway Corporation. These two tracks at the northerly end will pass directly under the Long Island R.R. terminal and by way of St. Felix St. will connect with the subway under Fulton St. coming from Manhattan Bridge, while at the southerly end they continue under Flatbush Ave. for a distance of a little less than one mile beyond the Prospect Park Plaza as far as Malbone St.

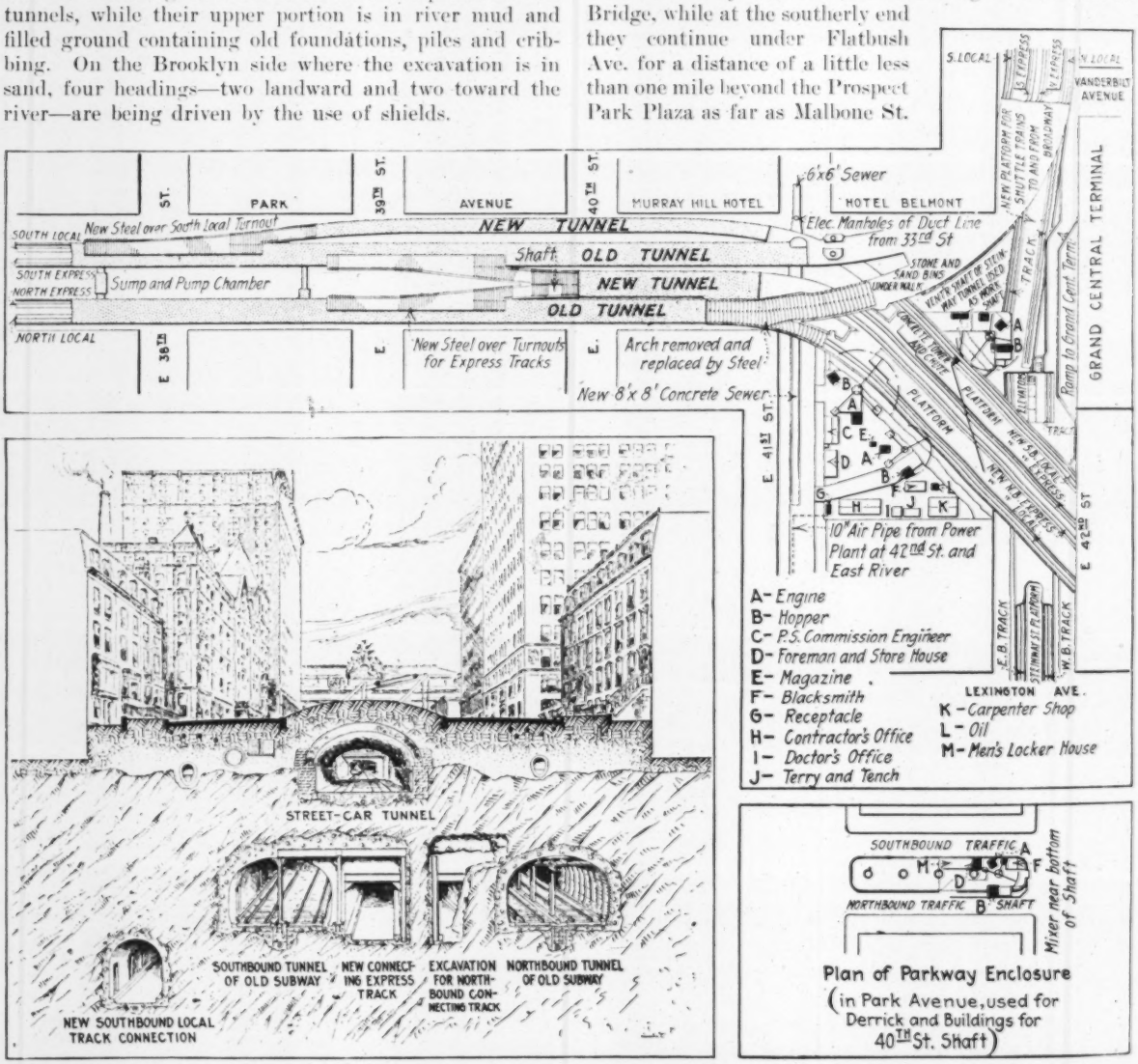
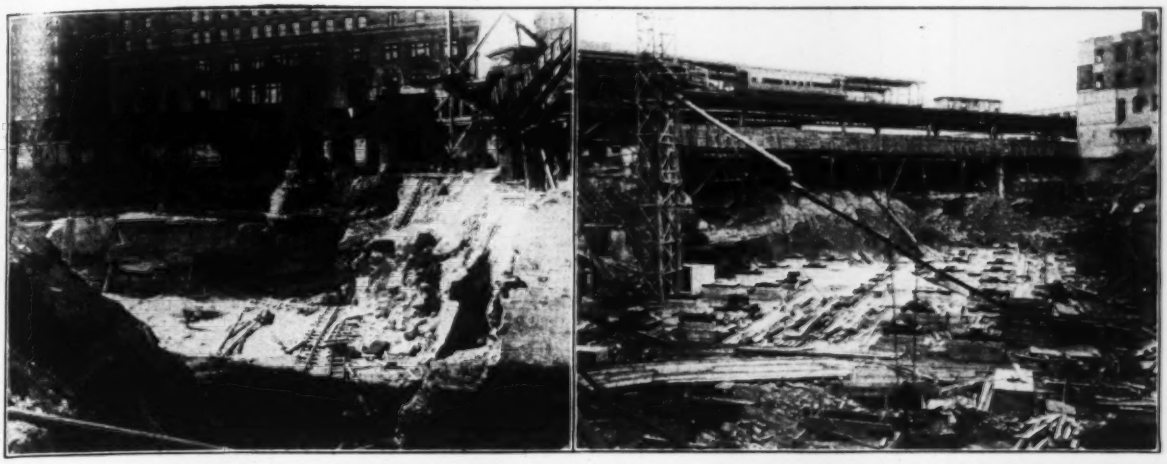


FIG. 5. DIAGONAL STATION AND TUNNEL CONNECTION TO EXISTING SUBWAY AT 42ND ST. AND PARK AVE.

The two double-track tunnels on either side of Park Ave. are the present subway curving west into 42nd St. Grand Central Station is just beyond the curve. The middle of Park Ave. is occupied by a double-track tunnel for street cars, with portal at 41st St. The new tunnels from Diagonal Station pass under these existing structures



FIGS. 6 AND 7. TWO VIEWS OF DIAGONAL STATION WORK, GRAND UNION HOTEL SITE
Left—Looking southwest. Right—Looking northeast

All this line is now in progress and is in various stages of construction, with the exception of the section under Flatbush Ave. between Prospect Park Plaza and Malbone St., which will be in soft-ground tunnel.

The Flatbush Ave. portion from Prospect Place to the Plaza, which was the first section let, is about 64% completed. Some of the other sections have only recently been let. Construction is being prosecuted in trench under street decking generally. Along Eastern Parkway, work is generally prosecuted in open cut. The excavated material is largely sand, gravel and clay.

The old two-track Steinway tunnel is being continued by a two-track subway extension westerly under 42nd St. to Times Square and by a two-track elevated extension from the easterly end in Long Island City, passing through the yard of the Long Island R.R., Davis St. and Ely Ave. to the Queensboro Bridge Plaza, where a junction is made with a two-track line from the bridge coming from the Second Ave. elevated line in Manhattan. From the Bridge Plaza two three-track elevated lines branch out into Queens—one over Jackson Ave. and Second Ave. to Astoria and the other along the Queens Boulevard,[1] Greenpoint Ave. and Roosevelt Ave. to Corona. There is a large double-deck union station on the Bridge Plaza under construction.

All of the Queens lines were started in 1913 and are now nearing completion. The work along Second Ave. to Astoria has already been finished.

New York Municipal Railway Corporation Lines—Broadway-59th St. Line

From the Manhattan end of the Whitehall St.-Montague St. tunnel a new subway extends north through Whitehall St., under Bowling Green, private property, Trinity Place, Church St., St. Paul's vestry building and churchyard, Vesey St., site of the southerly half of the old Astor House, Broadway and Seventh Ave., thence easterly through 59th St. to a point west of Fifth Ave. and curves diagonally across Central Park and the Plaza to 60th St., thence east to the East River and by tunnel under the river to Queens, where connection will be made with the Queens lines at the union station in Queensboro Plaza.

[1]The concrete-arch viaduct section of elevated railway along Queens Boulevard was described in "Engineering News" of Nov. 11, 1915, p. 913. The steel elevated railways were fully treated as to design in the issue of May 20, 1915, p. 971.

The portion of the subway on 59th St.—a two-track structure east of Seventh Ave.—as originally planned called for single-track tunnels in 59th St. and 60th St. between Fifth and Second Ave. These tunnels were to connect with the Queensboro Bridge, over which this line was to extend into the Borough of Queens. Objections to the use of the bridge for this purpose led the Board of Estimate and Apportionment to request that this line be carried in a tunnel under the East River. Accordingly a new two-track location was made across the Park Plaza and through 60th St., as outlined above.

The entire line is a two-track subway south of Park Place and (in general) a four-track subway north of Park Place as far as 59th St. Provision is made for a possible future extension of this line north of 59th St. to Central Park West and thence north; at present ony two of the four tracks continue across 59th St. Provision is also made at Canal St. for a connection with a two-track cross-town subway east of Broadway, which will connect with the Fourth Ave. subway in Brooklyn by way of the Manhattan Bridge.

Work on the Canal St. subway is now about 54% completed.

All the work on the Broadway-59th St. subway south of Union Square was started at various dates prior to 1914 and is now nearing completion; a number of the sections have already been finished. All sections north of Union Square are under construction. The last to be let—the section from 38th St. to 51st St.—passes beneath the Times Square station of the existing subway, which is on a curve turning from 42nd St. into Broadway.

The depth of excavation for this section varies from 44 ft. at 42nd St. to 24 ft. in the vicinity of 51st St. The rapid rate of progress required to complete this section on contract time and the excavation in uncertain New York rock in safety and without undue interference with traffic and adjacent property in one of the most congested portions of the city make the construction of this section especially interesting. Work began under this contract in the latter part of last year and is now well under way. The contract bid price is $3,740,913.50, and the contract time is 20 months for the completion of the railroad ready for operation.

The Broadway-59th St. line continues south of Morris St. under Whitehall St., by way of the new East